An Analysis of Structural Features, Contents, and Cognitive Levels of Questions of Korea and Secondary Textbooks in the Evolution Unit

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Abstract: The purpose of this study was to seek strengths and weaknesses from analyzing Korea and U.S. science textbooks in terms of general structural features, contents, cognitive levels of questions and the purpose of questions used in science textbooks. This provided insight into improvement of textbooks that can effectively assist teaching and learning. To investigate organization of unit in textbooks in-depth, the evolution unit was selected and scrutinized as one example. The results showed that the number of pages, activities, vocabulary words, and vocabulary lists are considerably different between Korean and the U.S. Commonly, U.S. textbooks were more laden with information and lacking in coherence than those of the Korean textbooks. The findings on the cognitive levels of questions showed that the majority of questions in both nations are concerned with knowledge. However, the difference between the two nations is great in the ratios of analysis, synthesis, and evaluation questions. Questions are concentrated in review section (45% of Korean and 60.6% of U.S.) in textbooks. It suggested that well-planned questions in a review section can provide the basic guidance for strength in a science classroom.

Key words: secondary science textbooks, structural features, contents, questions, purpose questions, cognitive level questions, organization

I. Introduction

Many factors influence teachers' instruction in science education; perhaps the most influential is the science textbook. Tyson(1997) claims that teachers mainly decide what topics and ideas are taught in class and how these topics are taught through the textbook. In spite of the many new curriculum materials that have emerged over the past, textbooks remain to be the most important source in science education (Stern & Roseman, 2004). Several studies have found that 90% of teachers use a textbook 95% of the time (Stake & Easley, 1978). This over-independence on textbooks led educators and researchers to be concerned with the quality of science textbooks. Whereas poorly designed textbooks can negatively affect student learning and teaching practices, well-designed textbooks used properly can be an influential tool for improving teaching and learning (Abraham *et al.,* 1992).

Among the many aspects of textbooks, historically, the general structural features and questions have been analyzed in research on textbooks (Chiang-Soong, 1998). Valverde, Bianchi, Wolfe, Schmidt, and Hounang (2002) state that the characterizing the general features of textbooks are important to understand the context in which learning the content embodied in the textbook takes place. Eltinge (1998) states that "the science taught in the science classroom is predominantly guided, organized and restricted to what is contained within the textbook." (p. 66). Gall (1970) stated that the presentation of information in the textbook plays an important rolein what is taught in the science class. General structural features of the textbook, including illustrations, vocabulary words, and suggested readings, fulfill the presentation function. Therefore, these general features must be designed to assist and facilitate students in learning the ideas presented in the text.

Questioning is "of great significance for teaching in class because its primary goal is to promote learning in the broad sense of the world" (Koufetta-Menicou

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& Scaife, 2000, p.79). Chiang-Soong states(1988) that questions and their use can be a powerful tool to aid and elicit inquiry. Science textbooks questions remain the most prevalent study aid used to assist students in developing an understanding of scientific knowledge (Leonard, 1987). As most teachers rely heavily on the textbook, the types of questions employed by the teacher have an important bearing on teaching by inquiry (Gall, 1970). With an emphasis on inquiry in teaching, the questions in textbooks must be better understood and used. Trends in International Mathematics and Science Study (TIMSS) conducted an international study of schools and student achievement. The findings of this study suggest that curriculum and textbook are very different across nations. Moreover, other studies point out that textbooks or other materials play an important role in explaining cross-national differences in educational opportunities and in student achievement (Stern & Roseman, 2004). The findings from the studies have encouraged educators and researchers to examine the factors that influence the weaknesses and strengths of textbooks and other instructional materials across nations (TIMSS, 2003). Thus, given the dominance of textbooks for teaching and learning, it seems important to conduct a careful study of textbooks between nations; yet, little research has been done in secondary school science in Korea and U.S.

The purpose of this study was to compare the commonly used middle and high school textbooks between Korea and U.S. with regard to general features and level of questions. Research questions include: (a) How do the textbooks differ in terms of the general structural features? (b) What is the difference in the cognitive level of questions among science textbooks? (c) What is the difference in the purpose of questions used in science textbooks?

Ⅱ. Review of Literature

Two lines of research are reviewed in this section: general structural features of textbooks and cognitive levels of questions in textbooks.

1. General Structural Features of Textbooks

General structural features refer to number of units, total pages, number of topics, concepts and number of questions. Identifying these features is useful in understanding how the content knowledge is learned (Park, 2005). Meyer *et al.* (1988)stated that given the dominance of textbooks in science teaching, it seems important to know about their content and characteristics. They compared content domains and vocabularies in 12 textbooks from four science programs. Their content analysis was conducted to describe how each publisher presents information, what types of questions are included, and what various text characteristics reveal obvious differences between various programs. In their search, they examined content, structure, and pictures and diagrams. They found that

1. There are substantial differences with content and pedagogy existed between textbooks.
2. Textbooks with the greatest amount of text had the most hands-on activities and fewer problems.
3. Programs with the greatest amount of content also had more teacher-directed activities.

Chiang-Soong (1988) examined five science textbooks most frequently used at the high school level. The analysis centered on six major areas: general features, terminology, readability, laboratory activities, questions in the narrative, two areas of scientific literacy. In the analysis of the general features, he identified and categorized to the features into the following groups; (a) prologue, outline and or guiding questions, (b) narrative, (c) pictures, tables, figures, illustrations and/or graphs, (d) laboratory activities, (e) short questions, (f) questions/programs, (g) summary, (h) vocabulary lists, (i) further investigations, (j) bibliography, (k) glossary, (l) appendices and (m) miscellaneous. She found that

1. There are large amounts of space, more than half of total pages of the books, devoted to components other than narrative.
2. The standard textbooks tend to include more topics and elaboration in the text.
3. Sentences in textbook emphasized specific facts for grading and testing purposes.
4. Tremendous page space is devoted to illustrations.

Lump and Beck (1996) examined basic textbook features as well as scientific literacy in 25 high school textbooks adopted in the state of Texas. For

descriptive information, they counted the number of chapters, total number of pages, total number of vocabulary terms and total number of lab activities. They found that descriptive information varied in the number of chapters and the total number of vocabulary terms in each textbook. The vocabulary terms ranged from 644 to 1,412, indicating that these biology textbooks contained a large number of vocabulary terms. Biology textbooks were centered primarily on the knowledge of science trends.

Valverde *et al.* (2002) extensively examined a total of 630 mathematics and science textbooks from 48 educational systems around world. They inspected multiple characteristics: (a) number of pages and graphics, (b) textbook structure (sequencing content), (c) content presentation, (d) performance expectation, (e) text segment devoted to a single main topic. They found that science textbooks in the U.S. contained more pages and topics than those in other countries. In particular, 4th or 8th grades in science textbooks in the U.S. contained less than 10% of inquiry activity blocks related to experimentation and real world inquiry. The physics textbooks included almost none. They also found a preponderance of narration in textbooks that emphasized the importance of more hands-on science.

Although many studies have examined general structural features of textbooks, little research has been done in secondary school science textbooks across nations.

2. Cognitive Levels of Questions in Textbooks

Textbook questions remain the most dominant aid used to help students learn information in science learning materials (Holliday, 1981). Crook (1961) described the function of questions in textbooks; "questions help students learn to discover, develop the scientific attitude, bring to students facts, theories, and principles, and keep students abreast of knowledge." (p.159). Wilson and Koran (1976) found that textbook questions influenced student learning by guiding students in their selection, encoding, and processing or textual information. Wixson (1983) showed that questions in textbook have appeared to cause significantly higher performance that textbook without questions. Unfortunately, teachers tend to fall into the routine of asking factual questions that are easily and quickly answered. Most questions asked in class are factual recall questions of information memorized from textbook reading (Edwards & Bowman, 1996). Low-level questioning contributes little to the development of critical thinking skills. As questions in textbooks assist students in attaining an understanding of science concepts, principles, and facts, questions asked in class depend on the quality of textbook questions (Pizzni, Shepardson & Abell, 1992). Sherpardson and Pizzini (1991) stated

> Textbook questions do more than provide a purpose, they also direct the students attention, and thus the selection of textual information. Furthermore, low-level cognitive questions over-prompt students'attention to textual information specific to the questions, resulting in student's falling to attain relationships between ideas within the text. (p. 674)

Andre (1976) found that higher level questions improve higher performance on text concepts. Questions in textbooks create a purpose for reading suggesting that low-level cognitive questions create a lower level of cognitive processing (Ulerick, 1989). As Wixson (1983) pointed out, the cognitive level of question encourage students to the interaction between prior knowledge and textual information. Carl (1967) claimed that to better understand textbooks, educators have to be aware of the various systems and categories which can be utilized in determining what a good question should be. Many classification systems have been proposed in recent years (Aschner, 1961; Bloom, 1956; Elder & Paul, 1997; Glaubman & Glaubman, 1997).

Many researchers have created different ways to categorize questions. Elder & Paul(1997) formulated three levels of questioning: concrete (Level 1), abstract (Level 2), and creative (Level 3). Franenkel (1966) listed four types of questions: factual, descriptive, explanatory, and heuristic. Aschner (1961) listed four main types of questions: remembering, reasoning, evaluating or judging and creative. Elder and Paul (1997) listed three types of questions: one-system, no-system, and multi-system. Glaubman and Glaubman (1997) categorized the types of questions as factual, convergent comprehending, and divergent integration.

Dahlgren and Oberg (2003) suggested five categories of questions: encyclopedic, meaning-oriented, relational, value-oriented and solution-oriented. Gall (1970) stated that most question classification systems are consisted of categories based on the type of cognitive process.

Most of the categorization of questions was drawn from Bloom's taxonomy (1956) that considered levels of thinking, including knowledge, comprehension, application, analysis, synthesis, and evaluation. These categories of the cognitive levels have been more widely utilized in the studies about questions in the past few years. Parks (1996) used Bloom's taxonomy in the classification of social studies texts accompanying selected textbooks. Davis and Hunkins (1996) analyzed textbook questions for history, geography, and fused social studies texts. They found that an overwhelming majority of the questions in each of the textbooks were concerned with knowledge where 78% of the textbook questions dealt with knowledge of specify. Sanders (1966) contribute to explanation and application of the taxonomy in the classroom and textbook questions.

Obviously, many studies have indicated that questions in science textbooks emphasized knowledge and factual questions rather than high-level questions. They also focused on an awareness of the potential value of including questions in textbooks and suggested improving questions in textbooks. However, while these studies focused on trends among textbooks within a single country, it is not clear whether such finding can be applied to textbook comparison between countries.

Ⅲ. Method

1. Materials

The middle school textbook selected for this study is the one published by Gyohaksa and the high school biology textbook is the one published by Jihaksa. These two publishers have published textbooks since the government allowed private publishers to publish textbooks and popular.

The U.S. textbooks selected for this study were among those identified by Weiss (2001) as one of most commonly used science textbooks. The Middle school science textbook for this study is one by Merrill and the high school biology textbook is one by Holt Rinehart & Winston.

In Korea, textbooks for grade 7-10 covers four areas of science, i.e., Chemistry, Biology, Geoscience, and Physics, in one volume for each grade while an upper grade high school textbook is published by science discipline. For this reason, when comparing textbooks for biology of the two countries four volumes of science textbooks from Korea and two high school biology textbooks were used in this study. On the other hand, textbooks in the US published by science disciplines. Therefore, two middle grade level biology textbook and one high school grade biology textbook were analyzed in this study.

2. Analysis

1) Comparison of General Features

Most textbooks usually repeat the same format in each chapter or unit. General features in common format include prologue, narrative, laboratory activities, summary, questions, vocabulary list and further investigations (Chiang-Soong, 1988). For analysis, several structural features of science textbooks were examined: units, chapters, topics, total pages, lab activity, illustrations, vocabulary, etc. Middle school science textbooks were limited in biology area and

Table 1

The Science Textbooks selected commonly used at the middle and high school science textbook both nations

Nation	Level	Grade	Title	Publisher	Title	Publisher	Nation
Korea	Middle	7	Science 1	Gyohaksa	Principle of Science 1	Charles E. Merrill	U.S.
		8	Science 2				
		9	Science 3		Principle of Science 2		
		10	Science				
	High	11	Biology Ⅰ	Jihaksa	Modern Biology	Holt Rinehart & Winston	
		12	Biology Ⅱ				

high school science textbooks were examined entirely. The comparison form was adopted partly by Chiang-Soong (1998). The general structural features were counted and recorded. For comparison of general structural features, descriptive statistics were used to explain the results.

2) Comparison of Structure of Evolution Unit.

The most important features in the textbook, namely, how textbooks are organized, depend on the sequencing of the content (Meyer, *et al.,* 1988). As mention earlier, teaching practice is influenced by the structure of the textbooks. It is meaningful to see the method of sequencing content in both countries because textbooks differ in the patterns of presentation of their various elements. Moreover, various elements differ in the way in which they are integrated with each other.

Although evolution unit is not representative of other units, it can meet the purpose of comparison of all textbooks as one example. The Evolution unit in each textbook was selected and scrutinized as one example for comparison because it provided a useful common way for understanding the structure of the unit in the biology textbook (Valverde *et al.,* 2002).

3) Cognitive Levels of Questions.

The analysis was focused on evolution-related chapters because of the contentious nature of this topic in the curriculum. All questions from these chapters were listed. The chapters sampled are presented in the Table 2. All questions in each chapter were analyzed. The analytical framework judged the cognitive emphasis of these science textbook questions using the Taxonomy of Educational Objectives, cognitive domain (Bloom, 1956). Within the Taxonomy, open-ended questions (i.e., questions not answered in the text) or close-ended questions (i.e., questions answered in the text) were considered. It is necessary to consider open-ended and close-ended questions for the exactness of the classification of the questions in textbook.

4) Purpose of Question

Chai and Jin (2004) stated that questions in textbooks are not to be isolated, but rather questions in context have purpose to meet teachers' and students' information needs. Although this study adopted Boom's cognitive levels, categorizing questions depended on the context in the textbooks. It is obvious that the purpose of questioning in textbooks has an influence on the categories of questions. For these reasons, the chapters/units were divided into six sections to examine the purpose of questions in context. According to the purpose of questions, the six sections are: (a) reflecting on prior knowledge, (b) motivation; (c) transition in topic (d) focusing on key points (e) guiding activity (f) review. The definitions are as follows:

a) Reflecting on prior knowledge questions: Located at the beginning of the unit or chapter for checking students' prior knowledge.
b) Motivation questions: Located at the introduction section for stimulating student motivation.
c) Transitions in topic questions: Located in the main text of the chapter and make transitions in topic.
d) Key point questions: Located on the page margin and highlight key point in reading portion.

Table 2

Selected Sample Chapters from Textbooks

Section	Korea	U.S	Korea	U.S
	Gyohaksa (Middle)	Merrill (Middle)	Jihaksa (High)	Holt Rinehart & Winston (High)
Sample Chapters	*The basic Evolution *Human Heredity *Organic evolution	*Heredity *Descent and Change *Human reproduction and Heredity	*Chromosome and Gene *Hereditary characteristics *Chromosomal abnormality and Genetic disease *Evolution evidence *Species and Classification	*Origin of Life *Evolution: Evidence and theory *The evolution of populations and speculation *Human evolution *Classification
Pages	38	61	40	98

e) Guiding activity questions: Located within activities and guide students to involve activities.
f) Review questions: Separated from the main text for review of the topic introduced in the section, unit, or chapter.

After categorizing textbook questions according to Bloom's taxonomy, the questions were re-examined and re-categorized by the purpose of questions mentioned above.

IV. Results

In this section, the findings of the analysis are presented in four sections. First, the comparison of general structural features of textbooks from each country at each grade level is presented. Second, the comparison of general structural features of Evolution Unit, organization of Evolution unit and content sequence of chapter are presented. Third, comparison of the cognitive levels of questions in the evolution unit is presented. Lastly, comparison of the purpose of question in textbooks is described.

1. Comparison of General Structural Features

Table 3 shows a listing of the general structural features at each grade level across nations. There were substantial differences between textbooks for the number of general features. In particular, the number of pages, activities, vocabulary words, and vocabulary lists are considerable differences shown.

In middle school textbooks on the biology area, Gyohaksa textbooks included a larger number of units, chapters, and illustrations than the US textbooks. In contrast, the Merrill textbooks had more topics, pages, and vocabulary. In particular, given the number of pages (e.g., 255 and 375 pages), Gyohaksa books, strikingly, have more hands-on activities (136) and at the end of unit activities (23), but Merrill textbooks have fewer activities (92) and do not include ends of activities. Merrill textbooks have separate vocabulary lists at the end of chapter, but there were not vocabulary lists in Gyohaksa. Gyohaksa had more supplemental sections than Merrill.

In high school biology textbooks, Holt Rinehart and Winston textbooks have almost twice as many as pages than Jihaksa. However, the Holt textbooks have less topics covered with less number of chapters but the number of vocabulary was almost four times more than Korean high school textbooks. The prologue in Jihaksa textbooks appeared at the beginning of unit and chapters in both places, while Holt textbooks had prologue section in the chapter.

Table 3

Comparison of General Features of Various Components of Selected Middle and High School Textbook

Features	Korea	U.S	Korea	U.S
	Gyohaksa (Middle)	Merrill (Middle)	Jihaksa (High school)	Holt R & Winston (High school)
	Science Textbook 1,2,3,4	Principle of Science 1,2	Science Biology 1,2	Modern Biology
	Number	Number	Number	Number
Units	9	4	22	10
Chapters	23	17	65	53
Topics	64	137	160	147
Pages	255	375	578	1043
Activities *At the End of chapter/unit Activities	136 *23	92 -	89 *42	101 *53
Prologue	32	21	57	53
Illustrations	317	297	520	684
Summaries	9	17	15	53
Vocabulary	203	325	379	1428
Vocabulary lists	-	17	-	53
Supplemental section	31	16	80	167

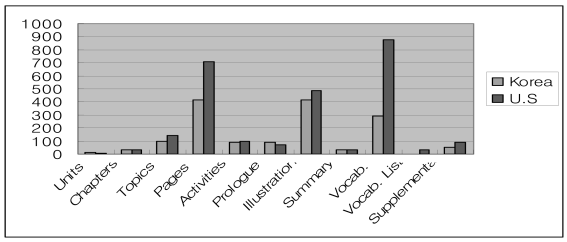

Fig. 1 *The Average Number of General Features in Textbook from Both Nations across Grade*

Fig. 1 presents the average number of general features of both nations. Strikingly, there are substantial differences on the total average pages and vocabulary in both countries. The number of total average pages (709) in the US textbooks is almost twice than Korean textbook (416.5). The vocabulary is almost four times. The prologue was presented in the beginning of chapter and unit, and then the sum of unit and chapter number is equal to the prologue number. At the end of activities just found in the unit in Korean textbook, but American textbooks contain them at the end of chapter. None of Korean textbooks have vocabulary lists at the end of chapter or unit.

2. General Structural Features of "Evolution Unit"

In order to investigate organization of unit in textbooks in-depth, unit on evolution was selected. Table 4 presents a count of each structural feature in evolution unit. Again, there are substantial differences between programs for the number of topics, pages, vocabulary, and questions. Holt textbook includes two times more pages than that of Korean textbooks in dealing with evolution unit. Merrill textbooks have more topics and Holt have more vocabulary words. In particular, Gyohaksa Korean textbooks contain more activities among textbooks. Commonly, U.S textbooks commonly contain more pages, vocabulary words, and questions than Korean textbooks.

1) Organization of "Evolution Unit.

The results of evolution unit structure comparisons are presented in Table 5. To examine the structure or organization of evolution, unit was divided into 6 sections: beginning, text, activity, text review, margin, end of chapter. Each section was examined and recorded in the form.

As the data show in Table 11, each textbook is very consistent in its presentation and/or format of the materials in terms of chapter or unit. For example, in Korean textbooks repeating structure is unit, while in America textbooks repeating structure is chapter.

In general, each unit in textbook starts with an introduction and objectives except Merrill. In particular, Jihaksa textbooks have self-test about previous knowledge at the beginning of unit. At the beginning of chapter Kyosaksa textbooks include "Think about it" and Jihaksa textbooks also contain "Reflection on background".

Activity sections are substantially different in that activities in Korean textbooks focus on scientific process skills such as observation and measurement and are located within the main text. In contrast, Holt, the US high school textbook contains quick labs in the margin and full investigations in the end of chapter. Similarly, Korean textbooks in the end of

Table 4
Comparisons of Evolution Unit in Each textbook

Features	Korea	U.S	Korea	U.S
	Gyohaksa (Middle school)	Merrill (Middle)	Jihaksa (High school)	Holt. (High Scho0l)
	Science 1,2,3,4	Principle of Science 1, 2	Science, Biology 1,2	Modern Biology
Chapters	3	3	7	5
Topics	9	24	22	15
Pages	38	61	45	98
Activities	17	8	4	9
Vocabulary	20	40	53	117
Illustration	51	51	47	59
Questions	91	128	93	280
Supplement section	4	4	6	12

Table 5

Evolution unit/chapter Structure for Middle and High School textbooks

Gyohaksa (Korea)	Merrill (U.S)	Jihaksa (Korea)	Holt. (US)
* Unit - Introduction - Objectives	* Unit - Introduction	* Unit - Introduction - Objectives - Check previous knowledge	Unit - Introduction - Chapter names
* Chapter 1. Beginning - Introduction - Objectives - Thinking about it 2. Chapter text - New terms (Boldface Type) - Questions 3. Activity - Scientific methods (e.g., observation, Experiment, measurement, discussion, interpretation, Investigation, Inference) 4. Text review - Questions 5. Margin - Vocabulary dictionary - Living and Science - Science in history * Science Place	* Chapter 1. Beginning - Introduction - Objectives 2. Chapter text - New terms (Boldface Type) - Phrases and sentence (italic) - Transition questions 3. Activity 4. Text review - Mare sure - Focusing on key questions 6. End of chapter - Main ideas - Vocabulary - Study questions - Investigations - Interesting reading	* Chapter 1.Beginning - Unit or chapter Instruction - Objectives - Reflection on background (e.g., Question) 2. Chapter text - New terms (Boldface Type) 3. Activity - Scientific methods (e.g., observation, Experiment, measurement, discussion, interpretation, Investigation, Inference) 4. Text review - Question - Problems - Exploration setions 5. Margin - Vocabulary on internet - Aha - Dictionary of person	* Chapter 1. Beginning - Chapter Introduction - Objectives 2. Chapter text - New terms(Boldface Type) 3. Activity - Quick lab 4. Text review - Questions - Critical Thinking 5. Margin - InternetConnect - Word roots and Origins - Eco-Connection 6. End of chapter - Section Review - Chapter Review - Summary - Review test - Critical Thinking - Extension 7. Investigation
* Summary of Unit * Supplement activity * Deepening activity * Unit Test	* Perspectives: Skills * Side roads	* Summary of Unit * Self-test * Unit Conformation quiz * Science and technology	-

unit section include “supplement activity and deepening activity.” Not only was text review section founded in all textbooks across nations, but the way of review section expressed is similar. Each textbook have specific sections in the margin section. For example, Korean textbooks repeat “Science in History” and “Aha” section to make up for chapter content. U.S textbooks also repeat “Internet Connect”, “Word roots and Origins”, and Eco-Connection to provide additional information.

2) Comparison of Sequencing Content of Chapter.

To examine content sequence of chapter, one of common chapter in evolution across nations was selected. Table 6 and 7 displayed content sequence of chapter in more detail for middle and high school textbooks from both nations. Common chapters both nations have different number of topics; in other words, each chapter receives different weight. For example, common chapter in Holt’s U.S. high school textbooks have 10 sub-topics compared with none in the Jihaksa’ Korean textbooks. This trend is also shown in middle school textbooks. These sub-topics clearly reflect divisions in the larger domain.

3) Cognitive Levels of Questions in Textbooks

A total of 592 questions from all textbooks in the parts covered evolution were classified according to Bloom’s taxonomy. Results of classifying the textbook questions according to the taxonomy are presented in

Table 6

Comparison of Sequencing Content of Evolution Chapter in Middle School Textbooks

Order	Gyohaksa (Korea) (8.3 Evolution of living things)	Order	Merrill (U.S) (21. Decent and Change)
1	Introduction	1	* Introduction
2	Objectives	2	* Objectives
3	Think about it	3	21:1 Origin of Living Things
4	8.3. Evolution of Living things	4	- Make sure
5	8.3.1 Where do various living things come from?	5	21:2 Darwin's theory
14	8.3.3. How do we explain evolution?	14	- Make sure
15	- Subtopic1: Theories of Evolution	15	* Perspectives
18	- Activity: What are the most conspicuous colors	18	* Study Questions
19	- Subtopic3: Theories Evolution after Darwin	19	- True and False
20	- Subtopic4: Modern theories of Evolution	20	- Multiple choice
21	- Activity1: Changes in Species	21	- Completion
22	- Activity2: Living things in Island	22	- How and Why
23	* chapter review	23	* Investigations
		24	* Interesting reading

Table 7

Comparison of Sequencing Content of Evolution Chapter in High School Textbooks

Order	Jihaska (Korea) (3.1 Origin of Living things)	Order	Modern Biology (U.S) (14. Origin of Life)
1	* Introduction	1	* Introduction
2	* Objectives	2	* Objectives
3	3.1.1 Primeval Earth	3	14.1 Biogenesis
4	3.1.2 The first Organic compounds	4	- Goals and Introduction
5	- Activity: Miller's experiment	5	- Subtopic1: Redi's Experiment
6	3.1.3. The first Life-Form	6	- Subtopic2: Spallanzani's Experiment
7	- Aha: The first genetic material	7	- Subtopic3: Pasteur's experiment
8	3.1.4. The first Life-Form and Evolution	8	- Section Review
9	- Problem	9	14.2 Earth's History
10	3.1.5. The first Eukaryotes	10	- Objectives and Introduction
11	- Exploration	11	- Subtopic1: The formation of Earth
12	- Chapter Review: Questions	12	- Subtopic2: The first organic compounds
		13	- Subtopic3: From molecules to cell-like structures
		14	- Section Review
		15	14.3 The first Life-Forms
		16	- Subtopic1: The origin of heredity
		17	- Subtopic2: The roles of RNA
		18	-Subtopic3: The first prokaryotes
		19	- Subtopic4: The first eukaryotes
		20	- Section review
		21	14.4 Chapter Review
		22	- Summary/vocabulary
		23	- Critical thinking
		23	- Extension
		24	14.5 Investigation: Making Micro-spheres

Table 8

Classification of Questions from Textbooks: According to the Taxonomy of Educational objectives: Cognitive domain.

Category	Middle school				High School			
	Gyohaksa (Korea)		Merrill. (U.S)		Jihaksa. (Korea)		Holt (U.S)	
	N	%	N	%	N	%	N	%
Knowledge	29	33.0	69	53.9	51	55.4	119	42.5
Comprehension	21	23.1	32	25.0	18	19.6	57	20.4
Application	23	26.1	13	10.2	8	8.7	23	8.2
Analysis	9	10.2	9	7.0	7	7.6	30	10.7
Synthesis	6	6.6	4	3.1	9	9.7	46	16.4
Evaluation	3	3.4	1	0.8	•	•	6	2.1
Total	91		128		93		280	
Total pages	38		61		42		98	
Ratio of per page	2.4		2.1		2.2		2.9	

the following table 8. The most salient difference of all is that the amount of questions and knowledge questions between the two countries is very different. In particular, Holt has more questions than the other textbooks. Gyohaksa texts contain 2.4 questions, Merrill series contain 2.1 questions, Jihaksa text contain 2.2 questions and Holt contains 2.9 questions. We calculated the relative proportions of cognitive level of questions counted based on the total number of all questions counted in each textbook. The percentage of knowledge questions across nations range from 33% to 55.5%. A majority of the questions in each textbook were concerned with knowledge items. Knowledge in the hierarchically the lowest Taxonomy was centered heavily on in each textbook across the nations.

1) Difference between Gyohaksa and Merrill formiddle school.

Fig. 2 presented the results the percentage of question levels at the middle school level in both countries in the content area of evolution. Both Merrill and Gyohaksa have more knowledge level questions than the other levels. In particular, Merrill has more knowledge questions about two times, and the ratio reverse for application questions in Gyohaksa textbooks. Comprehension questions, considered the lowest form of understanding in the Taxonomy, account for range from 23.1% to 25 % of total number of questions. However, Merrill texts havemore analysis whereas Gyohaksa texts have more synthesis questions. Overall, not only do they emphasize on knowledge questions, their questions revealed neglect of higher level questions.

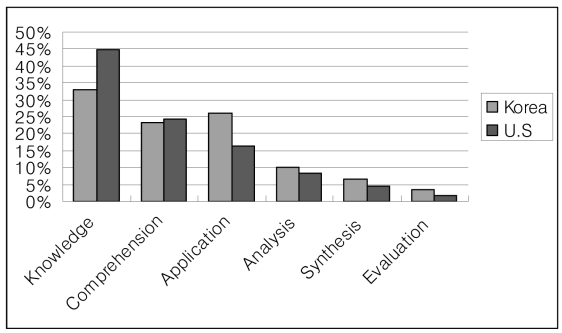

Fig. 2 Percentage of Question Levels from Gyohaksa and Merrill in Middle School

2) Difference between Jihaksa and Holt in high school.

The result of high school biology textbooks for Jihaksa and Holt were presented in the Fig. 3. Again, the majority of the questions in both nations are concerned with knowledge. The difference between two nations is great in the ratios of analysis, synthesis, and evaluation questions. In particular, the ratios of synthesis and evaluation questions in both countries were considerably different. Interestingly, no evaluation question was found in Jihaksa textbooks.

3) Difference between Korea and U.S across grades.

Results of classifying the textbook questions from Korean textbooks and U.S textbooks are presented in Fig. 4. In addition to dominant knowledge questions,

there are some differences on application, synthesis questions between nations. Korean textbooks in a category of application are higher, while American textbooks had respectively one higher category: synthesis. That is, Korean textbooks have more application questions in ratio twice than US textbooks. In contrast, the ratios of synthesis questions demonstrate an opposite.

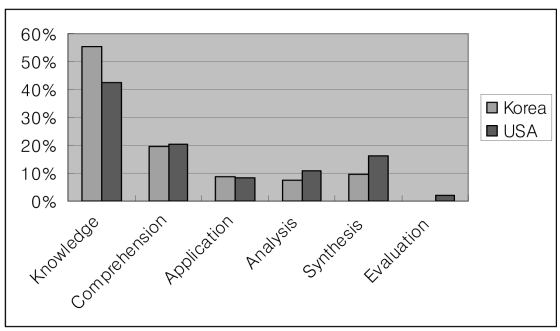

Fig. 3 Percentage of Question Levels from Jihaksa and Holt in High School

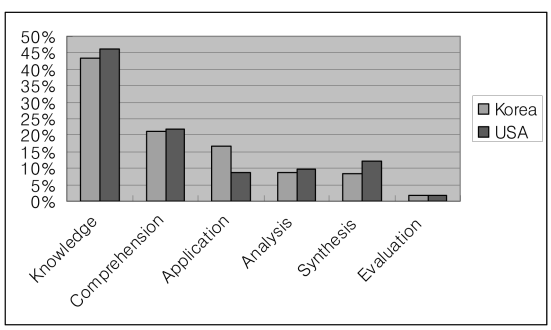

Fig. 4 Average of Question level in Middle and High school across Grade

4. Purpose of Questions in Context

The frequencies and percentage of questions by purpose of questions in context is illustrated in table 9. The six categories of questions purpose included: reflecting on prior knowledge, motivation, transition in topic, review, guide activities, and focusing key point. It was found that review questions and activity guiding questions were most frequent. Review questions ranged between 33% for Gyohaksa textbooks to 77.9% for Holt. Interestingly, Reflecting on prior knowledge questions was just found Jihaksa textbooks.

1) Difference between Gyohaksa and Merrill in middle school

The results of middle school textbooks both countries were presented in Fig. 5. There are substantial differences between textbooks. While Gyohaksa textbooks focus on review, guiding activities questions and motivation questions, Merrill textbooks center on motivation, transition in topic, review, guide activities and focus on key point questions. Gyohaksa textbooks have three times guiding activities questions than that of Merrill textbook. However, none of questions such as transition in topic and focusing key point was not found in Gyohaksa textbook.

2) Difference between Jihaksa and Holt in high school.

Fig. 6 showed the difference of occurrence of question in context in high school. The overall

Table 9

Classification of Question According to the Purpose of Questions in Context in Middle and High School Textbooks

Purpose \ Co.	Middle				High				Total	
	Gyohaksa		Merrill.		Jihaksa.		Holt & Winston			
	N	%	N	%	N	%	N	%	N	%
Reflecting on prior knowledge	•	•	•	•	5	5.4	•	•	5	0.8
Motivation	7	7.7	8	6.2	14	15.1	•	•	29	4.9
Transition in topic	•	•	7	5.4	•	•	10	3.6	17	2.9
Review	30	33.0	56	43.4	53	57.0	218	77.9	357	60.2
Guiding Activities	54	59.3	17	13.2	21	22.6	52	18.6	144	24.3
Focusing Key point	•	•	41	31.8	•	•	•	•	41	6.9
Total	91		129		93		280		593	

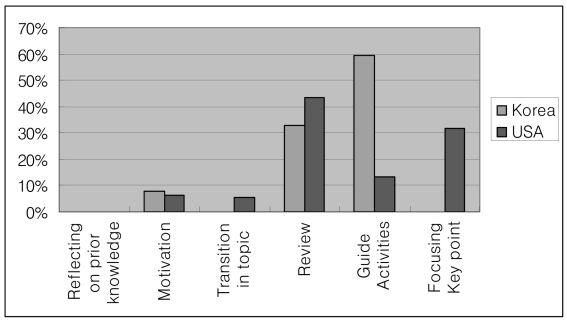

Fig. 5 Percentage of Questions Purpose in Context from Gyohaksa and Merrill textbooks in Middle School

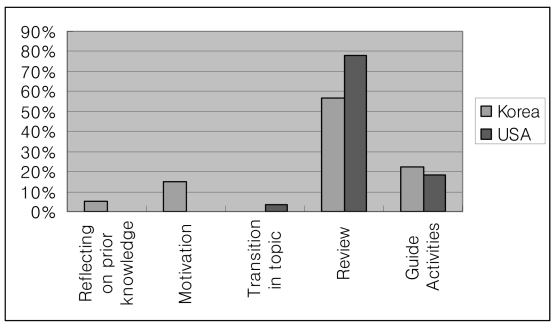

Fig. 6 Percentage of Questions Purpose in Context from Jihaksa and Holt textbooks in High School

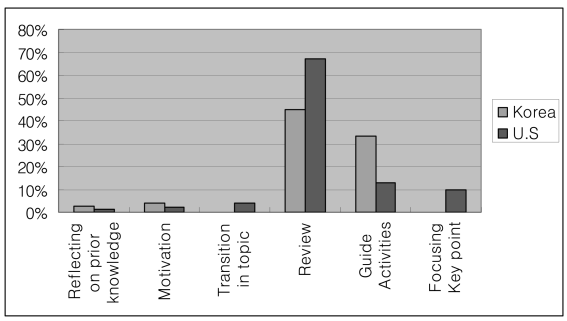

Fig. 7 Percentage of Purpose of Questions in Context in Middle and High school across Nations

percentages indicate that review questions are dominant between these texts. Transition in topic questions were just founded in American textbook, while Korean textbooks contained reflecting on prior knowledge questions and motivation question. Jihaksa and Holt do not have focusing key point questions.

3) Difference between Korea and U.S. across grades.

The results of classifying questions by the purpose of question in context for Korea and U.S were presented in Fig. 7. As might have been expected, an overwhelming majority of the questions in textbooks both countries were concerned with review. Totally, Korean textbooks include far more guiding activities questions than U.S. textbooks. Reflection on prior knowledge questions also was just included in Korean Gyohaksa textbooks. Likewise, transition in topic questions and focusing key point questions was just contained in each U.S. textbooks.

V. Discussion and Implication

Literature has shown that most science teachers use the assigned textbook as their content outline and story line for their course. In many cases it can be viewed as curriculum (Stake & Easley, 1978). Consequently, the content and methods science textbooks to which students are exposed are of great concern to science educators and researchers who are interested in promoting meaningful learning. In order to getting the findings expanded of previous studies, this study examined various aspects of science textbooks. In particular, this study shed some new insights into the continuing efforts to understanding science teaching in the U.S. and Korea.

The findings have shown that there are substantial differences on general structural features in middle and high school between Korea and U.S. In general, U.S. textbooks for middle and high school were generally more laden with information and lacking in coherence than those of the Korean textbooks. For example, Holt and Merrill's U.S. biology science textbooks include more pages and vocabulary words while covering less topics. This characteristic of US textbooks is evident when the evolution unit is examined and compared. The number of pages is one of the obvious characteristics of textbooks and usually other general features rely on this feature (Valverde *et al,* 2002). Further, an amount of vocabulary words directs student and teacher attention to focus on terms rather than on the concepts. Emphasis on vocabulary words in textbooks lead teacher to viewing science as information. It is easier for teacher to teach words than the concepts and emphasizes the memorization of definitions than critical thinking.

The large number of terms to be learned may lead to greater rote learning. In contrast to US textbooks, as we saw table 3, the Korean textbooks examined in this study have a more coherent design. This was also found by Park & Leung (2005). Second, as stated in the background, due to College Entrance Exam (CEE) adhere closely to the national curriculum, teacher and students rely heavily on textbooks to pass the exam. Secondary schools in Korea use Type Ⅱ which are published by private companies upon obtaining prior approval from the Ministry of Education. The textbooks reflect closely the national curriculum such as content and terms (Park & Leung, 2005). These are the reasons that the contents in Korean textbooks are introduced in a compressed way.

Interestingly, when compared the relative proportions of activities based on the total pages, Korean science textbooks usually have more activities than U.S textbooks. The science textbooks in Korea reflect the goals of the Korean national science curriculum. The seventh national science curriculum in Korea emphasizes the scientific methods to nurture inquiry (MOE, 1999). This message is that textbooks have to offer students opportunities to practice a variety of inquiry and problem solving skills (Park, 2005). Therefore, Korean textbooks contain various laboratory or practical activities rather than emphasizing information. This result explains the reason why the Korea textbooks have more guiding activities questions (average of 41%) in context (see table 9).

Jihaksa textbooks have another distinctive feature. In introduction part, they include reflection questions section. In the chapter introduction section, Jihaksa and Gyohaska also textbooks require students to reflect on their background related to chapter concepts. Martin (2000) stated that when teachers are familiar with a learner's prior knowledge they can provide learning experiences to build on these existing understandings. Tolman and Hardy (1995) suggested that activating prior knowledge is critical because what is learned is always learned in relation to what one already knows. Given the dominance of textbooks in science teaching, this section in Korean textbooks provides an effective first step to improving the practices of teaching in biology science.

Clearly, these data suggest that it is necessary to organize the content of textbooks that have a coherent and explicit design. Chambliss and Calfee (1989) stated that the detailed information or objectives are less important than conceptual growth. Shymansky *et al* (1991) found that teacher want textbooks that are logical, interesting, considerate of the reader than laden with information.

The findings on the cognitive levels of questions indicated that knowledge questions that require recall were emphasized to a considerable degree (43%~46%) over the other five higher levels of questions across nations. The emphasis on low-level questions likely requires students to recall, and textual information. Wixson (1983) stated that an extensive low-level question tends to prevent the student's cognitive level of interaction with information in textbooks. Dominant knowledge questions lead students' attention to a narrow view of information in the textbook and attract students to select specific information to the questions (Kleinman, 1965). Shepardson and Pizzini (1991) stated that the dominant use of low-level questions caused students to restrict textbook comprehension. The extensive of number of low level questions in textbooks may give seriously impact on science teaching. In particular, as mentioned above, since Korean science textbooks are the virtually sole teaching tools in class, teachers who teach and evaluate student's learning with questions in these textbooks are not nurturing the development of students' high-level thinking. However, although U.S. textbooks also emphasize knowledge questions, the influence of low level questions on science teaching is the less. Under the decentralized curriculum, there is more flexibility. Thus, they cater for the different needs and interests of the students. Park & Leung (2005) point out that US teacher sometimes modify the content in textbooks considering students' levels or their interests. They can choose appropriate topic as desired in various contents and materials in or outside textbooks in their science teaching.

Organizing different levels of questions stimulate students to get involved in higher-order inquiry processes (Lowery & Leonard, 1971). Shepardson and Pizzini (1991) implicated that there is a positive relationship between critical thinking questions asked

by teachers and students behaviors. Textbooks are substantial materials on which teachers create their lessons (Sewall, 2002). Therefore, textbooks need to contain more high-level questions which facilitate students to involve higher-order thinking skills. Pizzni *et al.,* (1992) states that increasing the number of higher level cognitive questions inserted enable students to become more experienced by replying to higher order cognitive questions. Holt and Merrill in the US tried to reflect high-level questions on their textbooks. Specifically, Holt in high school biology textbooks has a greater percentage of high level questions such as synthesis among other textbooks. Holt realized that high-level questions are presented in critical section in the textbook. It is recommended that developers of curriculum in science textbooks consider containing as many high-level questions as possible.

The results have shown that questions in the textbooks of this study are concentrated in the review section. Review section in textbooks is an effective way for students and teachers to look back on student's understanding on concepts and planning next learning. Most of the questions in the review section fall into the lowest level of Bloom's cognitive level, i.e., recall (Pizzini *et al.,* 1992). as we pointed out table 9, given the dominance of review section questions (45% of Korean and 60.6 % of U.S.), it appears that improving questions in review section in textbook is closely related to the quality of questions in the textbook. Well-planned teacher review questions in the science classroom for meaningful inquiry learning provide the basic foundation for a strong inquiry program in class. Therefore, review section questions should be carefully written with facilitation of students' high level thinking in mind.

The findings in this study demonstrate substantial variations in science textbooks between the two nations. The differences and their own strengths and weakness provide insights into improvement of textbooks that can effectively assist teaching and learning.

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