ANALYSIS OF QUESTIONS IN THE SCIENCE TEXTBOOK OF THE 4TH AND 2ND SEMESTERS (4-2) IN ELEMENTARY SCHOOL

Byeong Ryong Lee
Department of Biology Education/Seowon University
Republic of Korea
brlee@seowon.ac.kr

Man Kyu Huh*
Department of Applied Bioscience/Dong-eui University
Republic of Korea
mkhuh@deu.ac.kr

ABSTRACT

A question is an utterance which typically functions as a request for information, which is expected to be provided in the form of an answer. We investigated the characteristics of the questions presented in the elementary school 'Science 4-2' textbook in Korea. The total number of sentences and question sentences were 796 and 240, respectively. The percentage of questions asked about the total number of sentences averaged 30.2% for five chapters. Many sentences were non-textual sentences such as inquiry activities. The ratio of first-stage questions, combined with text and non-text, was 74.2%.The mid-stage was 11.7% and the end-stage was 17.1%. Since the x^2-values for the text and the non-text were 186.56 ($p < 0.001$) and 2.03 ($p < 0.05$), respectively. The experiential questions were 8.8% for the text and 8.3% for the non-text, respectively. Among cognitive abilities, only two categories of 'knowledge' and 'Application' were presented at text. There was no sentence for 'Understanding', 'Analysis', 'Evaluation', and 'Evaluation'. In the compositional analysis of the questions, only two categories of ' Investigation' and 'Openness' were presented at text. Many questions are set in the non-text sentences such as ‘inquiry activity’ and ‘think more’.

Keywords: Elementary school, Question, Science 4-2 textbook.

INTRODUCTION

Question is an interrogative expression often used to test knowledge or an interrogative sentence or clause. Inquiry-oriented science curriculum programs are provided about inquiry and about science subject matter. Science textbooks with a research question are effective inquirers and the better question science books to engage students in inquiries that will help them understand scientific concepts and inquiry.

All inquiry instruction and activities start with a research question, which students attempt to answer through data analysis (Bell, Smetana, & Binns, 2005). Inquiry-based questions support student investigation about science technology engineering and math. The ability to generate a good research question requires the cognitive process of analyzing data (Anderson & Krathwohl, 2001) and this skill must be developed. The specific instructional supports needed for processes of inquiry to promote elements, such as critical thinking skills and flexible problem solving abilities (Cairns, 2019). Scientific investigations, whether conducted by students or scientists, begin with observations of something interesting or perplexing, which lead to scientific questions, and then to reflections on what the person already knows about the question. As students mature and gain experience with inquiry, they will become adept at clarifying good questions, designing investigations to test ideas, interpreting data, and forming explanations based on data. With such students, the teacher still should monitor by observation, ask questions for clarification, and make suggestions when needed. Often, teachers begin the school year providing considerable structure and then gradually provide more opportunities for

student-centered investigations (National Academies of Sciences, Engineering, and Medicine, 2000).

Questioning is one of the most effective ways to get students involved in the delivery of the lesson. Recognition of children's questions is a metacognitive process since it focuses students' attention on content and promotes deeper thinking (Chin & Brown, 2002).

Student achievement is highly related to the quality of questions they ask (Harper, et al, 2003; Chin & Osborne, 2008). Higher-level questions are more influential in constructing knowledge than those of lower-level questions (Hofstein et al., 2005; Zhang, et al., 2007). Higher-level questions activate critical reasoning, synthesis and evaluation skills, thus providing a deeper level of understanding (Graesser & Person, 1994).

Science explains every aspect of our lives. Children entering primary school are naturally inquisitive about the world around them, forever asking "Why?" (Gormley et al., 2019).

The science textbooks are usually designed to serve as an aid in selecting quality children's science concepts and information, conducting science classroom activities for teacher and students, and teaching resources. The gradual development of understanding in science that we aim for in inquiry-based science education depends on pupils using inquiry skills and competences that are employed by scientists such as raising questions (Carulla, 2012).

There are many types of questioning techniques that occur in the classroom. Teacher-posed questions typically serve formative and summative assessment needs, (Marbach-Ad & Sokolove 2000; Keeling et al. 2009) whereas student-posed questions are aimed at resolving misunderstandings that arise within the lesson.

The purpose of this study is to provide an overview of how the 'Science 4-2 Textbook' presents the questions and find out the location, composition, and roles of questions in the national elementary school textbook.

METHODOLOGY

This study were the national elementary school 'Science 4-2' textbook developed and used in accordance with the current curriculum, and were asked questions in five chapters (Table 1). First chapter is Plant observation (Table 2). Second is the changes in water conditions, 3rd, Shadows and mirrors, 4th, Volcanoes and earthquakes, and 5th, Water travel. Statements or statements do not have a questionable form or sentences with other functions other than the question were not considered questions in this study.

The research tool used the Text Questioning Strategies Assessment Instrument (TQSAI) (Lowery & Leonard, 1975), developed by the University of California as part of a collaborative teacher preparation project in 1975. It is a tool to analyze the frequency, form, and location of questions presented in textbooks and examine the exploration process in which questions are asked to examine whether there are meaningful differences in questions for each textbook chapter or unit. The form of the tool divides the questions into two top categories of empirical (experience) and non-experiential questions, each consisting of several subcategories, but here we treat them as separate items due to the large number of questions.

The location of the question was divided into the title or introduction step, intermediate step, and finishing or organizing step in any section. The analysis of questions about the exploration process was divided into knowledge, understanding, application, analysis synthesis, and evaluation. The composition of the questions was divided into investigation, information, focus, openness, and value. The analysis of questions about problem solving was divided scientifically, technically, socially, and routinely. Exploration composition methods for questions were divided into knowledge, exploration, and attitudes.

The chi-square of frequences or mean values to infer whether differences exist among the questions was tested. Except where stated otherwise, statistical analyses were performed using the SPSS software (Release 21.0).

Table 1. The science textbook of the second semester of the fourth grade (4-2) in the elementary school used in this study

Code	Copyright holder	Compilation	Publishing company	Date of publication
4-2	Ministry of Education and Human Resources Development	Korea Foundation for the Advancement of Science & Creativity	Chenjae Textbook	2020, 8

Table 2. Composition of the elementary school science 4-2 textbook

Chapter	Title	Page volume (the beginning and end pages)	No. sentences
1	Plant observation	22 (8-29)	134
2	The changes in water conditions	24 (30-53)	183
3	Shadows and mirrors	24 (54-77)	167
4	Volcanoes and earthquakes	25 (78-101)	166
5	Water travel	19 (102-119)	146

RESULTS

The total number of sentences was 796, and the first chapter was 134, the second chapter was 183, the third chapter was 167, the fourth chapter was 166, and the fifth chapter was 146 (Table 2). Many sentences were non-textual sentences such as inquiry activities. For example, there were only 47 practical sentences of 134 in Chapter 1. The rests were non-text sentences. The total number of question sentences was 240, and the first chapter was 48, the second chapter was 52, the third chapter was 55, the fourth chapter was 56, and the fifth chapter was 29 (Table 3). The total number of question sentences in text was 34, and the first chapter was 5, the second chapter was 8, the third chapter was 9, the fourth chapter was 10, and the fifth chapter was 2. The total number of question sentences in text was 206. The percentage of questions asked about the total number of sentences averaged 30.2% for five chapters. The chapter with the highest ratio was 35.8% in Chapter 1, while the chapter with the lowest ratio was 19.9% in Chapter 5. Many question sentences in the textbook were presented in inquiry or investigation activities. Many questions in text were placed at 79.4% in the initial stage at the location of the question. Many questions in non-text were placed at 73.3% in the initial stage at the location of the question. The ratio of first-stage questions, combined with text and non-text, was 74.2%.The mid-stage was 11.7% and the end-stage was 17.1%. Since the x^2-values for the text and the non-text were 186.56 ($p < 0.001$) and 2.03 ($p < 0.05$), respectively. There were significant differences in text between units. Then the output in the location of the questions in the science textbook did not assumed equal variances.

The experiential questions were 8.8% for the text and 8.3% for the non-text, respectively (Table 4). Non-experiential questions were 91.2% in the text and 91.8% in the non-text. There were significant differences between units ($x^2 = 29.08^*$ for text, $x^2 = 173.91^*$ for non-text).

Table 3. The location of the questions in the science textbook for the first semester of the third grade of elementary school

Step	Chapter					Total
	1	2	3	4	5	
Introduction	5(30)	6(33)	7(34)	7(35)	2(19)	27(151)
Intermediate	0(5)	2(3)	2(4)	3(5)	0(4)	7(21)
Finish	0(8)	0(8)	0(8)	0(6)	0(4)	0(34)
Total	5(43)	8(44)	9(46)	10(46)	2(27)	34(206)

$x^2 = 168.56^{***}$ for text, $x^2 = 2.03$ for non-text, $^{***}: p < 0.001$.

Table 4. Experience and non-experience of the questions in the science textbook

Step	Chapter					Total
	1	2	3	4	5	
Experience	1(4)	0(4)	2(6)	0(2)	0(1)	3(17)
Non-experience	4(39)	8(40)	7(40)	10(44)	2(26)	31(188)
Total	5(43)	8(44)	9(46)	10(46)	2(27)	34(206)

$x^2 = 29.08^{**}$ for text, $x^2 = 173.91^{***}$ for non-text, $^{**}: p < 0.01$, $^{***}: p < 0.001$.

Table 5. Analysis of questions about the cognitive ability in the science textbook

Chapter	Knowledge	Understanding	Application	Analysis	Evaluation	Evaluation	Total
1	5(32)	-	0(7)	0(3)	0(1)	-	5(43)
2	7(5)	-	1(6)	0(3)	0(0)	-	8(44)
3	8(34)	0(2)	1(10)	-	-	-	9(46)
4	10(45)	-	0(1)	-	-	-	10(46)
5	2(22)	0(2)	0(3)	-	-	-	2(27)
Total	32(168)	0(4)	2(27)	0(6)	0(1)	0(0)	34(206)

$x^2 = 2.14$ for text, $x^2 = 131.47^{***}$ for non-text, $^{***}: p < 0.001$.

Questions were analysed in various categories of cognitive ability (Table 5). Among cognitive abilities, only two categories of 'knowledge' and 'Application' were presented at text. There was no sentence for 'Understanding', 'Analysis', 'Evaluation', and 'Evaluation'. "Knowledge" and "Application" were 94.1% and 5.9%, respectively. ‘Knowledge’ was also the most common in non-text (81.6%). Questions about the exploration process differed a lot among the units. So, there were significant differences between units ($x^2 = 31.47^{***}$ for non-text).

In the compositional analysis of the questions, only two categories of ' Investigation' and 'Openness' were presented at text (Table 6). ‘Investigation’ was also the most common in non-text (73.3%). There were significant differences in the composition of the questions among the chapters ($x^2 = 16.99^{**}$ for non-text).

Table 6. The composition of the questions in the science textbook

Chapter	Investigation	Information	Focus	Openness	Value	Total
1	5(32)	-	0(3)	0(7)	0(1)	5(42)
2	6(33)	-	-	2(11)	-	8(44)
3	7(32)	0(2)	-	2(12)	-	9(46)
4	9(35)	0(1)	-	1(10)	-	10(46)
5	2(19)	-	-	0(8)	-	2(27)
Total	29(151)	0(3)	0(3)	5(48)	0(1)	34(206)

$x^2 = 2.47$ for text, $x^2 = 16.99^{**}$ for non-text, $^{**}: p < 0.01$.

'Routine' was the lowest in the analysis of questions about problem solving (Table 7). There were not significant differences between units ($x^2 = 3079$ for text). Even in non-text, knowledge was the least and there were significant differences between units ($x^2 = 8.67^{*}$ for non-text).
In the compositional analysis of the questions, ' Knowledge' was the highest (Table 8). Next was 'Exploration'. There were significant differences between units at non-text ($x^2 = 15.53^{**}$).

Table 7. The analysis of questions about problem solving in the science textbook

Problem solving	Chapter					Total
	1	2	3	4	5	
Scientific	0(8)	0(2)	0(5)	0(5)	0(0)	0(20)
Technical	5(32)	7(38)	7(36)	10(38)	2(24)	31(168)
Social	-	-	0(1)	-	-	0(0)
Routine	0(3)	1(4)	2(4)	0(3)	0(3)	3(17)
Total	5(43)	8(44)	9(46)	10(46)	2(27)	34(206)

$x^2 = 3.79$ for text, $x^2 = 8.67^{*}$ for non-text, $^{*}: p < 0.05$.

Table 8. Exploration composition methods for questions in the science textbook

Composition method	Chapter					Total
	1	2	3	4	5	
Knowledge	4(38)	6(34)	7(35)	7(33)	2(25)	26(165)
Exploration	1(11)	2(10)	2(10)	3(7)	-	8(38)
Attitude	-	-	0(1)	-	-	0(3)
Total	6(49)	8(44)	9(46)	10(46)	2(27)	34(206)

$x^2 = 1.27$ for text, $x^2 = 15.53^{**}$ for non-text, $^{**}: p < 0.05$.

DISCUSSION

It is now widely acknowledged that textbooks exert a powerful influence on American education (Armbruster & Qstertag, 1993). Since textbooks have such a powerful influence on classroom instruction, it is important for educators to be informed about the questioning practices in commercially published materials. One significant component of textbooks is questions. Specifically, the study addressed the issue of how many and what kinds of questions appear in elementary science. Many research have been conducted which highlighted the importance of the questions in textbooks (Yaman, 2017). For example, Stern and Ahlgren (2002) state that questions in textbooks do not provide a positive contribution to the development of students, whereas Armbruster and Ostertag (1993) and Meyer, Crummey and

Greer (1988), indicate that there are differences between the distributions of the questions in textbooks. Huh (2021) reported an overview of how the textbook presents the questions and find out the location, composition, and roles of questions in the national elementary school 'Science 3-2' textbook in Korea.

As pointed out by Huh (2021), many exploration activities in the science textbook in elementary school, are set up in each chapter. Textbooks for the second semester of the 4th grade are no exception. In this paper many questions are set in the non-text sentences such as ‘inquiry activity’ and ‘think more’. Too many questions can reduce students' interest or lead to indifference. It is impossible for an individual to be aware of and pay attention to everything at the same time (Cicekci & Sadik, 2019).

There was a lot of significance in the chi-square test between chapters (Tables 3-8). Many questions was uneven in form. Of course, there are characteristics among five chapters, but textbook authors need to intentionally try to evenly distribute various forms of questions. Kim et al. (2014) analyzed the types of questions of energy field in the elementary science textbooks and to know the preference types of questions of students by grade. They pointed out the questions in the elementary science textbooks, the types of limited question were the most frequent (56%) and the next was the type of relevant question(41.82%).

Questions should be timely where necessary. In the 4th and 2nd semesters, an auxiliary textbook called 'Experimental Observation' is provided, and most of them are sentences of questions after explaining the experimental process. Most of the 'exploration activities' in textbooks overlap with the 'experimental observation' in the experiment. In terms of content, there were many questions that required answers without experience rather than questions that could be answered empirically. Empirical questions are less than 9% and more than 90% are non-experiential questions (Table 4). In that case, it can cause diffuse thinking, but for young students with little experience, it is inevitable that the specificity will be reduced. In the composition of questions, knowledge was much more than observation or attitude (Table 8). Dixson and Worrell (2016) review the traditional definitions of formative and summative assessment and highlight the characteristics and use of both in classroom settings. Thus, questions of textbooks should be described for use with student teachers in teacher education programs.

In conclusion, effective questioning in science instruction moves students from curiosity to interest to reasoning. These questions provide an excellent way of making student thinking visible whilst also providing an opportunity for students to extend their own thinking about a topic. The kinds of questions science textbooks ask, the interaction strategies they use, and the students of whom they ask questions have not been the focus of many science education studies. The cognitive aspects of questions have been researched more than have the affective aspects.

REFERENCES

Anderson, L.W., & Krathwohl, D.R. (2001) *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*, (Complete edition), New York: Longman.

Armbruster, B., & Ostertag, J. (1993) Questions in elementary science and social studies textbooks. In B.K. Britton, A. Woodward, & M. Binkley (Eds.), *Learning from textbooks: Theory and practice.* Hillsdale, NY: Lawrence Erlbaum Associates, Publ.

Bell, R.L., Smetana, L., & Binns, I. (2005) Simplifying inquiry instruction. *The Science*

Teacher, 72, 30-33.

Cairns, D. (2019) Investigating the relationship between instructional practices and science achievement in an inquiry-based learning environment. International *Journal of Science Rducation, 41,* 2113–2135.

Carulla, S.B. (2012) *Tools for Enhancing Inquiry in Science Education*. Fiboacci-Project. EU. France.

Chin, C., & Brown, D.E. (2002) Student-generated questions: A meaningful aspect of learning in science. *International Journal of Science Education, 24 (5),* 521-549.

Chin, C., & Osborne, J. (2008) Students' questions: a potential resource for teaching and learning science. *Studies Science in Education, 44,* 1-39.

Cicekci, M.A., & Sadik, F. (2019) Teachers' and students' opinions about students' attention problems during the lesson. *Journal of Education and Learning, 8,* 15-30.

Dixson, D.D. and Worrell, F.C. (2016) Formative and summative assessment in the classroom. *Theory Into Practice, 55,* 153-159.

Gormley K., Birdsall S., & France B. (2019) Socio-scientific issues in primary schools. *Teaching and Learning. 2019,* DOI:10.18296/set.0139

Graesser, A.C., & Person, N.K. (1994) Question asking during tutoring. *American Educational Research Journal, 31,* 104-137.

Haper, K.A., Etkina, E., & Lin, Y. (2003) Encouraging and analyzing student questions in a large physics course: Meaningful patterns for instructors. *Journal of Research in Science Teaching 40,* 776-791.

Hofstein et al (2005) Developing students' ability to ask more and better questions resulting from inquiry-type chemistry laboratories. *Journal of Research in Science Teaching, 42,* 791-806.

Huh, M.K. (2021) The pattern analyses of questions in the science textbook of the second semester of the third grade in elementary school. *European Journal of Advanced Research in Biological and Life Sciences, 9,* 9-15.

Kaya, S. (2015) The effect of the type of achievement grouping on students' question generation in science. *The Australian Educational Researcher, 42,* 429-441.

Kim, M.J., You, P.K., & Lee, H.C. (2014) Analysis on type of questions in elementary science textbooks and elementary school students' preference types of questions. *Journal of the Korean Society of Earth Science Education, 7*, 64-74.

Lowery, L.F., & Leonard, W.H. (1975) *A study of questioning style among four widely used biology textbooks*. University of California Cooperative Teacher Preparation Program, Research Report QS-3. University of California, Berkeley.

Meyer, L.A., Crummey, L., & Greer, E.A. (1988) Elementary science textbooks: Their contents, text characteristics, and comprehensibility. *Journal of Research in Science Teaching, 25,* 435-463.

National Academies of Sciences, Engineering, and Medicine. (2000) Inquiry and the national science education standards: A guide for teaching and learning. Washington, DC: The National Academies Press.

Stern, L., & Ahlgren, A. (2002) Analysis of students' assessments in middle school curriculum materials: Aiming precisely at benchmarks and standards. *Journal of Research in Science Teaching, 39,* 889-910.

Yaman, S. (2017) Investigating consistency of questions in primary and middle school science textbooks with objectives in science curriculum. *Journal of Education and Training Studies, 5,* 81-89.

Zhang et al (2007) Socio-cognitive dynamics of knowledge building in the work of 9- and 10-year-olds. *Educational Technology Research and Development, 55,* 117-114.