Comparative Study of Trends and Patterns Within the Test Content between Junior High School Science Textbooks and Ehime Prefecture's High School Entrance Examination

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Abstract

The purpose of this study was to investigate trends and patterns within the test content of Junior High School science textbooks. For this purpose, 511 questions were extracted and organized into a text database to analyze the method of questioning, as well as the content of the questions. Questions were grouped into the following formats: "short answer", "written answer", or "multiple choice answer". Their content was grouped into the following categories: "scientific terminology", "calculations", "explanation of natural phenomena", "explanation of reasoning", and "figures and graphs".The particular characteristics of the questions were examined, and the following two conclusions were drawn. (1) The "written answer" format and the "explanation of reasoning" question content appear less frequently in all fields. (2) The"explanation of natural phenomena", and"scientific terminology" questions accounted for 60 percent of all questions. These results were compared with the trends and patterns within the test content of Ehime Prefecture's High School Entrance Examination. As a result, it became clear that the questions of Junior High School science textbooks and Ehime Prefecture's High School Entrance Examination had similar trends and patterns.

[Keywords:] Questioning, Science Textbooks, The method of questioning,
The question contents

Introduction

Even if science teachers gave students lessons in same natural phenomena, differences in teaching methods had a strong influence on the students' understanding. For example, teaching science using graphs and using calculations produced completely different results. Suffice it to say that teacher's questions for students have a very important role since they change the depth or extent of students' ability to think. Therefore, it's important for teachers to carefully think about the questions in their lessons.

Sumida (2008) stated that most teachers' questions in their lessons are based on the test content of Junior High School science textbooks. Thus, analysis of textbooks leads to the analysis of classes. In this regard, analysis of textbooks seems significant.

The results of TIMSS (Trends in International Mathematics and Science Study) about the analysis of solution has been argued in various form as a large-scale international investigation. Saruta (2001) reported the detailed analysis of the solution of the elementary/lower secondary school students in the Japanese-Australian two nations. He pointed out a tendency to increase quantity of description in the Japanese-Australian students whenever a school year went up it. Nakayama(2004) and Saruta(2006) pointed out that the Japanese junior high school students have lower rate of mean correct answer for the description-style problem than other countries. This was caused by the fact that Japanese students' responded using the words of the problem sentence. Sumida(2005) originally develop a new frame to classify description-style answers in of TIMSS. He pointed out that the use of scientific term occupies the important position conclusively. Further, he emphasized the significance of "writing" it in the science learning.

Thereupon, Yamaoka(2010) investigated trends and patterns within the test content of Ehime Prefecture's Upper Secondary School Entrance Examinations over the past thirty-one years. As a results, the "written answer" format and the "explanation of reasoning" question content appeared less frequently than other types of questions in all of fields of study. In addition, there was a variation in all fields for both question types and question contents.

The subject of this study is the entrance examination problems that impose various restrictions on science classes. It suggests concrete clue that the trial to measure the characteristic quantitatively results to class improvement, thereby leading to promotion of both thinking faculty and sound judgement, and recognition of the significance of writing in science class. Ultimately, the study aims to contribute to the reform of science classes. Using grouping method of Yamaoka (2010), the study investigated the characteristic for the Junior High School science textbooks. Furthermore, the study dealt with trends and patterns within the test content between the results of analysis and Ehime Prefecture's Upper Secondary School Entrance Examinations.

The process of this study

(1) Subjects of analysis

Our subjects of analysis were Japanese science textbooks approved by the Ministry of Education. From now on, I will refer to these targets of analysis simply as “Science Textbooks”.There are four such Science textbooks.They are called, ”Field 1- first volume”, ”Field 1-last volume”, ”Field 2-first volume”, and ”Field 2-last volume”.For the most part, Field one includes content relating to Physics and Chemistry, while Field two includes content relating to Biology and Earth science.

(2) Process of analysis

The purpose of this study is to clearly delineate how the Method of Questioning for Science-related Items in Science textbooks has trended. For this purpose, all information of characters included in Science Textbooks were extracted as text date. After that, all 511 questions from there were extracted as text data. The date was divided into four sections, that is Field 1- first volume, Field 1-last volume, Field 2-first volume, and Field 2-last volume. And the secondary data were extracted and organized into a text database to analyze the method of questioning, as well as the content of the questions. The total numbers of questions in Field 1- first volume were 145, in Field 1-last volume were 114, in Field 2-first volume were 118, in Field 2- last volume were 134, and analyzed it for 511 in total.

Trends and patterns within the test content of Science textbooks

(1) Grouping of the method of questioning in Science textbooks

All 511 questions were grouped into the following formats: "short answer", "written answer", or "multiple choice answer". Here, “short answer” means the questions describing only the answer to scientific terminology, calculation result, and so on. And, "written answer" refers to the questions giving an answer with free description. "Multiple choice answer" pertains to questions that allows students to choosing an appropriate sign among the choice. Using this grouping, questions of the science textbook were rearranged. The results are shown in Table 1.

Table1. Results of the frequency of the method of questioning in science textbooks

Field	Grouping of the method of questioning in Science textbooks			Total
	Short answer	Written answer	Multiple choice answer	
Field 1-first volume	54	41	50	145
Field 1-last volume	59	20	35	114
Field 2-first volume	39	28	51	118
Field 2-last volume	70	23	41	134
Total	222	112	177	511

※ The numbers in the table refer to the frequency of questions

The results of the chi square calculations, Table1 accept the null hypothesis as true (χ^2=17.30, df =6, p<.01). The results show that Field 1-first volume featured a great deal of written answer-based items. In Field 2-first volume, multiple choice answer-based items are increasing, while short answere-based items are decreasing. All things considered, written answer-based items are small in all fields.

(2) Grouping of the content of the questions in Science textbooks

By the grouping mentioned above, even if it is the question included in the same kind, the contents were varied. For example, there is an actual question, like the following:

Question A: “What gas is generated, if you combine from the reaction of limewater and hydrochloric acid?”
Question B: “After the lightning six seconds, came the thunder. Calculate how far is it from here?”

Both question A and question B are the same grouping, in other words both are included in “short answer”. But, question A is grouped into "scientific terminology". And, question B is grouped into "calculations". The contents of 511 questions were divided into the following groups: "scientific terminology", "calculations", "explanation of natural phenomena", "explanation of reasoning", and "figures and graphs". Here, "scientific terminologies" are questions describing scientific term. "Calculations" deals with questions describing calculation results. Moreover, "explanation of natural phenomena" refer to questions describing rule or law concerning a natural phenomenon. "Explanation of reasoning" are questions describing a fundamental principle. Finally, "figures and graphs" pertain to questions that yield answers using figures and graphs that students make. Table2 shows the five categories and the actual example in the science textbooks.

Table2. The five categories and the actual example

Groups	For a characteristic question
Scientific terminology	●What gas is generated, if you combine from the reaction of limewater and hydrochloric acid?(Field 1-last volume)
Calculations	●After the lightning six seconds, came the thunder. Calculate how far is it from here?(Field 1- first volume)
Explanation of natural phenomena	●A cloud is made in the frontal surface of the warm front. How does the height of this cloud change by the distance from a warm front?(Field 2- last volume)
Explanation of reasoning	●Why is it that covered a part of the leaf in aluminum foil? (Field 2- first volume)
Figures and graphs	●Show the laboratory finding of the resistor to a graph A - C. (Field 1- first volume)

Considering the grouping described in Table 2, rearrangement of the questions on the science textbooks was also performed. The results of the rearrangment are shown in Table 3.

Table3. Results of the frequency of the content of the questions in Science textbooks

Field	Grouping of the question contents in Science textbooks					Total
	Scientific terminology	Calculations	Explanation of natural phenomena	Explanation of reasoning	Figures and graphs	
Field 1- first volume	23	27	45	10	40	145
Field 1-last volume	47	10	34	6	17	114
Field 2-first volume	53	2	44	8	11	118
Field 2-last volume	29	7	32	13	53	134
Total	152	46	155	37	121	511

※ The numbers in the table refer to the frequency of questions

The results in Table 3 shows that, generally, the "explanation of natural phenomena", and"scientific terminology" questions accounted for 60 percent of all questions. On the other hand, “explanation of

reasoning" accounted as the lowest for 7.2 percent. The results of the chi square calculations, as shown in Table 2 accept the null hypothesis as true (χ^2=62.98, df=12, p<.01). Residual error analysis yielded the results as follows: In Field1-first volume, "scientific terminology" are decreasing, while "calculations" are increasing. In Field 2-first volume, "scientific terminology" are increasing, while both "calculations"and "figures and graphs" are increasing. As a result, it became clear that the questions of Field1-first volume and Field 2-first volume had similar trends and patterns.

Figure 1 shows the frequency of the content of the questions in science textbooks using percentages. In all fields, the ratio that accounted for "explanation of natural phenomena" is high. About "scientific terminology", both Field 1-last volume and Field 2-first volume occupied more than approximately 40 percent. From these characteristics, Field 1-last volume and Field 2-first volume showed similar tendencies.

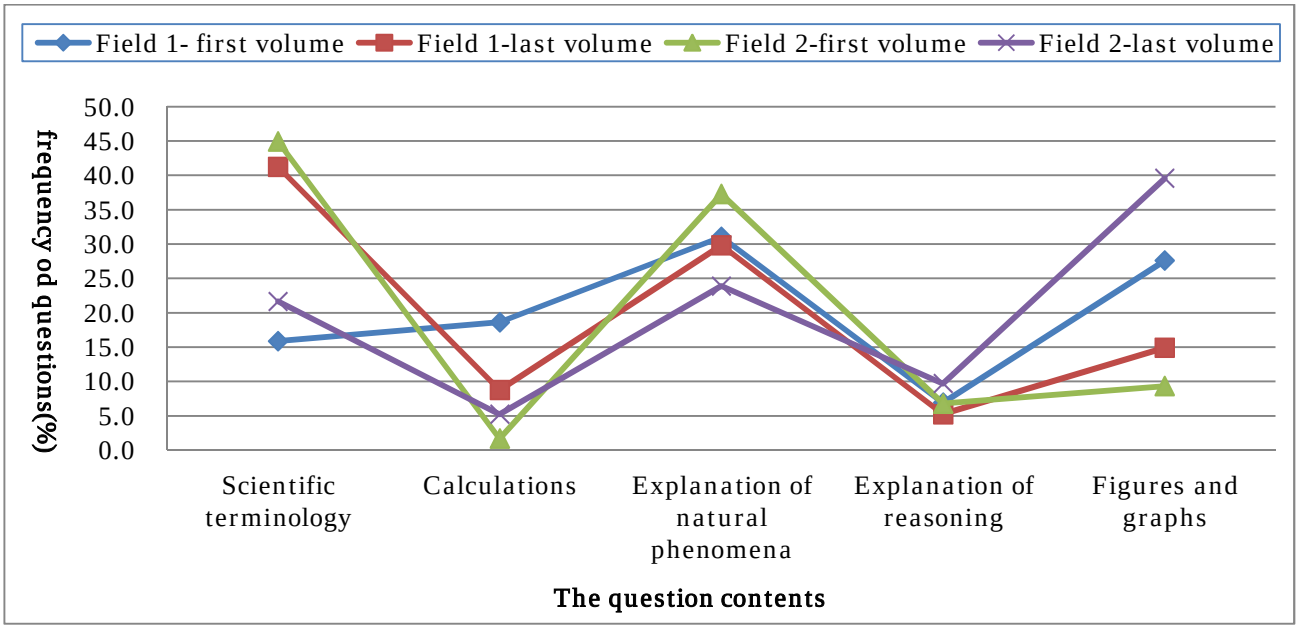

Figure1. Results of the frequency of the content of the questions in Science textbooks (%)

(3) Comparative Study of Trends and Patterns Within the Test Content between Junior High School Science Textbooks and Ehime Prefecture's High School Entrance Examination

The results of trends and patterns within the test content of science textbooks were compared with the test content of Ehime Prefecture's High School Entrance Examination. Yamaoka (2010) investigated trends and patterns within the test content of Ehime Prefecture's Upper Secondary School Entrance Examinations over the past thirty-one years. For this purpose, 1,331 questions were extracted and organized into a text database to facilitate an analysis of the method of questioning, as well as the content of the questions. 1,331 questions were grouped into the same formats that use the analysis of science textbooks. Table 4 shows a summary of the comparative study of trends and patterns within the test content between science textbooks and Ehime prefecture's high school entrance examination.

Table4. Comparative Study of Trends and Patterns Within the Test Content between Science Textbooks and Ehime Prefecture's High School Entrance Examination

questioning	Science textbooks	Ehime Prefecture's Upper Secondary School Entrance Examinations
the method of questioning	In Field 1- first volume, "written answer" occupy many ratios.	Different tendencies
	In Field 2-first volume, "multiple choice answer" occupy many ratios.	Very much Similar tendency
	In Field 2-first volume, "short answer" occupy few ratios.	Very much Similar tendency
	In all fields, "written answer" occupy few ratios.	Very much Similar tendency
the content of the questions	On each average in all fields, both "explanation of natural phenomena" and "scientific terminology" occupied 30%.	Similar tendency
	The least "explanation of reasoning" in 7.2% of the whole.	Very much Similar tendency
	In Field 1- first volume, "scientific terminology" occupy few ratios.	Very much Similar tendency
	In Field 1- first volume, "calculations" occupy many ratios.	Very much Similar tendency
	In Field 2-first volume, "scientific terminology" occupy many ratios.	Very much Similar tendency
	In Field 2-last volume, "figures and graphs" occupy many ratios.	Very much Similar tendency

About half of the question in the Science textbooks accounted for contents form of both "scientific terminology" and "explanation of natural phenomena". More importantly, trends and patterns within the test content of Science textbooks and Ehime Prefecture's High School Entrance Examination had similar trends and patterns.

The "written answer" format and the "explanation of reasoning" question content appeared less frequently in all fields. But the ratio of the method of questioning "written answer" was approximately 22% of the whole (in 511 questions), whereas the ratio of it was 6% of the whole (in 1,331 questions). Basing on the content of the questions "explanation of reasoning", the Science textbooks had not reach 8% altogether.

Conclusion

It became clear that the questions of science textbooks and Ehime Prefecture's High School Entrance Examination had similar trends and patterns. The questions of science textbooks contained more of the "written answer" format and the "explanation of reasoning" question than those included in the Ehime Prefecture's High School Entrance Examination. From the great number of the "written answer" format and the "explanation of reasoning" questions, it can be deduced that Japanese Science classes have a lot of opportunities to use the "written answer" format.

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