Social Relations Embedded in a Finnish Mathematics Textbook for the Seventh Grade

Fumihito Ikeda*

Institute for the Advancement of Higher Education, Hokkaido University

Abstract — My former studies clarified that Finnish education, which has maintained the world's highest level as shown in an international academic assessment, helps children learn through various kinds of social relations. This study was conducted to examine how a Finnish textbook supports children's learning. I analyzed the non-mathematical words that appear in the "number and calculation" unit of a seventh grade Finnish mathematics textbook, and determined what kinds of mathematical contexts the words are used in. I found that the Finnish mathematics textbook contained a great many more non-mathematical words than Japanese ones and helps children learn through the social relations that are given by the words. In the future, I will analyze more textbooks and develop some Japanese mathematical materials to support children's learning through social relations.

(Received on 5 July, 2010)

1. Introduction

Finland has maintained the world highest level in the Program for International Student Assessment (PISA) conducted by the Organization for Economic Cooperation and Development (OECD) every three years. On the other hand, Japanese children's science literacy has declined to the second-level group, their mathematical literacy dropped to the bottom of the second group, and their reading ability fell to the world average level [National Institute for Educational Policy Research, 2007]. In my previous studies, I examined the factors that caused such differences from the viewpoints of (1) Finnish educational support for children's learning through various social relations (learning by socio-constructivism)[Ikeda, 2008] and (2) the human skills that are needed in the entrance exam for the teacher training course of Oulu University [Ikeda, 2010].

However, it would take very much time and great efforts to introduce the Finnish learning methods and teacher training system into Japan. Since teachers have to help children construct their own knowledge through various social relations by themselves, the expected role of teachers in the Finnish learning method is very different from that of today's Japanese teachers. Therefore today's Japanese teacher training system would have to be changed from its very roots. Even if the system can be changed and teachers who can support such learning are educated, it will be difficult for such new-type teachers to display their ability in real school activities if the incumbent teachers and parents cannot change their thoughts on education. On the other hand, it is also difficult to intro-

*) Correspondence: Insitute for the Advancement of Higher Education, Hokkaido University, Kita 17 Nishi 8 Kita-ku, Sapporo 060-0817, Japan

duce a Finnish-type entrance examination for the Japanese teacher-training course, since Japanese universities are in a severe struggle for existence because of the decrease in the number of children. Even teacher training courses of national universities cannot help reducing the number of subjects of the original entrance examination to secure a sufficient number of candidates. For example, the results of a study examining what subjects national teacher training education colleges (there are eight in Japan) assigned for the 2011 entrance examination showed that two colleges will have no academic tests in either the first- or second-round examinations , and that six will have some academic tests only in their first examinations. Of the latter six colleges, three will have only science tests, two will have science and mathematics tests, and one will have science and national language tests. Assigning various subjects like in Finland weakens their competitiveness in the struggle to gain students. Furthermore, the social surroundings of education in Finland are very different from Japan. For example, the social status of a teacher is very high and there is a great deal of competition in all teacher training courses in Finland [Ikeda, 2010]. Therefore it is not practical to change the entrance examination in order to change Japanese teacher training system.

It is a family that is relatively free from such social factors preventing a revolution of Japanese education system. So it is a realistic way to spread the Finnish learning by socio-constructivism among Japanese families. To promote this, we need to develop some materials that support such learning in a family. Therefore I analyzed a Finnish mathematics textbook for grade 7 (corresponding to the first year of junior high school in Japan) and investigated what kinds of social relations were embedded in the textbook. I hope that this investigation will enable us to develop a Japanese version of such a text.

The reasons I choose the textbook are as follows. Concerning reading ability, which is the most serious problem in Japan, it is easy to get some Finnish textbooks that are translated into Japanese [Pale, et al., 2005; 2006; 2007]. On the other hand, for science, many Japanese researchers have studied various Finnish textbooks or Finnish teacher training systems and various school lessons in Finnish primary and secondary education [Suzuki, 2007]. However, for mathematics, it was only pointed out that other subjects were also involved in a Finnish mathematics textbook [Ikeda, 2008]. Nevertheless, mathematics is the second serious problem in Japan. The gap between mathematics in elementary school and mathematics in junior high school leads children to dislike it [Iwasaki&Okazaki, 1999][Kunimune, 1997][Tanizawa, 2000]. This situation suggests that it is worthwhile to analyze the Finnish mathematics textbook for the seventh grade.

2. Methods

I chose “Laskutaito (Numeracy) 7” [Laurinolli, et al. 2007] as the Finnish mathematics textbook for grade 7. It was published by WSOY, which is one of the biggest textbook publishers in Finland. This textbook has 300 pages and the list of its contents is shown in Appendix 1.

I analyzed the “numbers and calculations” part (from sections 1 to 28) in this textbook, which deals with addition, subtraction, multiplication and division of integers and rational numbers. The reason why I did so was that this part is the first turning point from mathematics in primary school (“Sansu”) to mathematics in junior high school (“Sugaku”)[Okazaki, 2003] and is not only the foundation of the later contents [Yanagimoto, 1990] but also the cognitional foundation for numerical formulas [Linchevski, 1999].

To examine the social relations embedded in this part, I extracted all of its non-mathematical words, and then (1) categorized them and examined how many words belonged to each category, and (2) analyzed what kinds of mathematical contexts they appeared in. Here, social relations means various relations such as personal relations and social roles in the family or job, and person-to-social relations constructed through the media or in some public services such as schools, government offices, etc. [Gergen, 1999]. Socio-constructivism thinks that our knowledge is not constructed in the head independent of these social relations, but rather through social relations and maintaining these relations [Gergen, 1994]. Moreover our knowledge is not based on facts and truth, but depends deeply on “language”, which is just social relations [Gergen, 1994; 1999]. Therefore, by analyzing what kinds of language are used in the mathematics textbook, the social relations embedded in it are clarified [Gergen, 1994; 1999]. In other words, the use of non-mathematical words in a mathematics textbook means that the mathematical knowledge is explained by the social relations the non-mathematical words represent.

3. Results

Each section in the textbook consists of three parts: example questions and their explanation, training questions and applied questions. I call these sentences the main text. In addition to the main text, there are sentences in figures, tables and topics related to the main text. First, I extracted non-mathematical words from all of these sentences and categorized them. The categories of the words, and the number of words in each one are shown in Table 1. Second, I examined how these words were used in the sentences and found the following tendencies.

3.1 Person names

First of all, domestic personal names appear in the main texts and are used for problem settings like "Eetu ate three-fifths of the pizza." On the other hand, worldwide names such as "Sherlock Holms", "Dr. Watson", and "Sir Arthur Conan Doyle" are used mainly in some world records. Only these three words were used in the topic of section 27. In this section children read each question and answer "who is guilty?" by using the mathematical knowledge that was explained before the question.

3.2 Place names

Domestic place names appear mainly in sections 1 and 22. In section 1, which deals with the addition of positive numbers and negative numbers, a map of Finland and its related table contain such words, which are used in questions like, "The morning temperature in Helsinki was +1 degree and this was forecast to rise +3 degrees during the day. What temperature will it become in the day in Helsinki?" The theme of section 22 is addition, subtraction, multiplication and division of decimals, and children calculated the distance of a trekking course based on distances between points on a contour map of an area of Finland. On the other hand, world place names appear mainly in sections 1, 6, 21 and 25. In section 1, the heights of the highest point and the lowest point in each area of the world are shown in a table, and the differences of the two points are calculated. Section 6 deals with demographic changes around the world. In section 21, some calculations of decimals are based on the track and field records of the Sydney Olympic Games. The theme of section 25 is "travel" and various countries' currencies and their exchange rates are dealt with in it. Furthermore, worldwide place names are also used in some topics with photos.

Table 1. The numbers and kinds of non-mathematical words in the Finnish mathematics textbook

Category	Subcategory	Number of words
Persons	Domestic	36
	Worldwide	12
Places	Domestic	24
	Worldwide	47
Science	Biology	41
	Astronomy	25
	Chemistry & Physics	18
Daily life	Drink & Food	21
	Household goods	13
	Sports & Playing	26
	Travel	39
	Economy	21
	Social	44
Total		367

For example, section 4 deals with subtraction of negative numbers, and as a related topic an episode with a vulture is introduced. That is, it is a vulture in Cote d'Ivoire that among animals flies the highest in the world.

3.3 Science words

Among science words for biology, animal names appear most frequently. The appearance of animal names is classified into two types: in topics with photos like the vulture previously mentioned and in the results of some calculations. For example, given a correspondence table between numbers and letters, children transform the correct answers of some calculations into letters by referring to the table and then they get an animal name. Plant names, which were mainly vegetables and fruits, appear with their prices and amounts in questions.

Almost all of the words on "astronomy" appear in section 26, whose theme is "the solar system and space." In this section calculations of distances between planets or galaxies and conversions from astronomical units (AU) into light years are presented.

The words on chemistry and physics are used mainly in sections 1, 23 and 26. In section 1, there is a question comparing some temperatures like the melting point of oxygen, boiling point of mercury and so on. Section 23 contains an applied question related to low-fat milk, and in this question lactose, calcium, vitamins and so on appear as the ingredients of it. Section 26 deals with some calculations involving speed.

3.4 Daily life words

Words about daily life appear most frequently of all the non-mathematical words. Drink and food names or household goods are related to their prices or amounts in some questions. There are two cases in which words related to sports and playing appear. In the first case, they are used with time, speed and distance, and their values are calculated. In the second case, they appear in a survey result on what kinds of sports young people play in section 20. The ratio of each sport is represented as a fraction and calculated. Most of the words on travel appear in section 25 as representations of currencies, exchange rates, transportation costs and so on. The words of economics are used to explain some consumer behaviors in questions. They are accompanied by person names and place names. The category "social" contained words that represent family relations like "mother" and "aunt", social phenomena like "crime" and "refugee", social roles like "rector" and "police", time designations like "November" and "Sunday" and so on. These words are used to explain realistic problems with personal names and place names in the same way as the economic words.

4. Discussion

The result of categorizing the non-mathematical words in the Finnish mathematics textbook showed that its mathematical knowledge contained four types of social relations: Person, Place, Science and Daily life.

The fact that the mathematical knowledge is expressed using various persons' names shows children that mathematics is combined with real human activities. Especially the fact that many domestic personal names are used in various mathematical contexts shows children that they can learn mathematics through their activities in their real lives. On the other hand, the fact that worldwide persons' names appear shows children that they can learn mathematics in relation to people throughout the world. These facts help children learn by socio-constructivism through people.

The fact that the mathematical knowledge is expressed by using various place names shows children that mathematics is connected to real places. Especially the fact that many domestic place names are used in various mathematical contexts shows children that they can learn mathematics through familiar places. On the other hand, the fact that worldwide place names appear shows children the connection of mathematics to the relations of places throughout the world. These facts help children learn by socio-constructivism through places.

Science terms mean social relations in school to children, because they become familiar with these terms mainly in school. These terms are related to nature (mainly through many animal names), the physical world (mainly through words on astronomy and physics), and industrial materials (mainly through chemical terms). Thus, science terms help children learn by socio-constructivism through science activities in school.

Terms from daily life, which are accompanied by persons' names or place names, help children learn mathematics through their ordinary daily lives. This fact shows

children that social relations constructed through children's daily lives are embedded in mathematical knowledge.

5. Conclusion

As discussed in the previous section, four types of social relations are embedded in the Finnish mathematics textbook for grade 7. However, this conclusion does not mean that if we incorporate socio-constructivism in Japanese textbooks we can improve Japanese education because I have not yet discussed whether Japanese textbooks on mathematics show the same tendency in the usage of non-mathematical words. If they do, we should admit that the decline in mathematical literacy in Japan is not due to the textbooks.

To compare Japanese textbooks with Finnish textbooks, I chose non-mathematical words from a mathematics textbook for first year junior high school published by Kyouiku Shuppan. This textbook is used by 12 of the 24 school districts in Hokkaido. The result of categorizing the words in this textbook is shown in Table 2 and all kinds of words and their categories are shown in Appendix 4.

Although the usages of these words in mathematical contexts are almost the same as in the Finnish text, the variety of non-mathematical words in the Japanese textbook is extremely limited compared to the Finnish one. From this fact, I conclude that there is a much weaker tendency for the Japanese mathematics textbook to connect mathematical knowledge with various kinds of social relations than in the Finnish one.

Two main problems remain to be dealt with. One is that more textbooks should be analyzed. It is possible that the Finnish textbook analyzed in this study happened to contain many non-mathematical words, or conversely, that the Japanese textbook analyzed in this study contained very few non-mathematical words by chance. Therefore it is necessarry to analyze more mathematics textbooks to reach a firm conclusion. The other problem is to develop some mathematics materials that support learning via socio-constructivism in the family. As pointed out above, the results and conclusion cannot be generalized exactly as they are. However, it is important to understand that the Japanese textbook analyzed in this study was published by the leading textbook publisher in Japan. Thus, because

Table 2. The kinds of non-mathematics words in a Japanese mathematics textbook

Category	Subcategory	Number
Person	Domestic	4
	Worldwide	0
Place	Domestic	16
	Worldwide	4
Science	Biology	0
	Astronomy	1
	Chemistry & Physics	5
Daily life	Drink & Food	0
	Households	1
	Sports & Playing	7
	Travel	7
	Economy	3
	Social	13
Total		61

many Japanese children learn mathematics through this textbook, I hope to develop some mathematics learning materials that are embedded with various kinds of social relations and examine their effect as soon as possible.

References

Fumihito Ikeda, Human Skills Required for Entering Teacher Training Course of Oulu University [in Japanese], Journal of Higher Education and Lifelong Learning, Vol.17, pp.1-8, 2010

Fumihito Ikeda, An Examination of the Knowledge Acquisition Process in Finnish Education [in Japanese], Journal of Higher Education and Lifelong Learning, Vol. 15, pp.147-154, 2007.

Hideki Iwasaki and Masakazu Okazaki（岩崎秀樹，岡崎正和），算数から数学への移行について (1)―代数和の位置づけとその指導―，数学教育学研究 , 5, 85-90, 1999.

Masakazu Okazaki（岡崎正和），全体論的視座からの正負の数の加減の単元構成に関する研究 ―教授学的状況論と代数的思考のサイクルの視点から―，数学教育学研究 , 9, 1-13, 2003.

Susumu Kunimune（国宗進），『確かな理解をめざした文字式の学習指導』, 明治図書 , 1997.

National Institute for Educational Policy Research（国立教育政策研究所），『生きるための知識と技能』, pp.iii-xv，ぎょうせい，2007.

Hiroaki Tanizawa（谷沢浩明），文字式の指導に関する考察―操作的と構造的な捉え方の視点から―，上越数学教育研

Appendix 1. Contents of a Finnish Mathematics Textbook for 7 grade

The number of each title shows its page number which the section bigins

Appendix 2. Categorization of Non-Mathematics Words in a Finnish Mathematics Textbook for 7 grade

Category	Examples	Number of words
Person's name	<Domestic> 36 Eetu, Juho, Jere, Tiina, Anu, Katja, Arttu, Lauri, Leevile, Jaakko, Jannelle, Tommile Riikalle, Liisa, Hanna, Jonna, Iiro, Leena, Susan, Anna, Elsa, Seija, Ilari, Tanja, Sampo, Pekka, Matti, Terhi, Herroilla Jokinen, Jarvinen, Virtane, Asko, Esko, Usko, Olli, Niilo, Tuomas <Worldwide> 12 Marion Jones, Obadele Thomson, Aziz Zakari, Maurice Greene, Jonathan Drummond, Kim Collins, Dwain Chambers, Darren Campbell, Ato Boldon, Sherlock Holms, Dr. Watson, Sir Arthur Conan Doyle	48
Place name	<Domestic> 24 Helsinki, Tampere, Turku, Jyvaskyla, Oulu, Utsjoki, Kittila, Sodankyka, Kayaani, Vaasa, Lappeenranta, Vantaa, Yllasjarven, Mount Yllas, Varkaankurun laavu, Ojanlalva, Kahvikeittan laave, Tunturijarvi, Yllasjarvi, Yllastunturin, Yllasjarvelta, Ojanlalvan, Kahviketaan, Porttipahta lake <Worldwide> 47 Arabia, Cote d'Ivoire, Abidjanin, Kongo, Ruanda, Niragongon, Romania, Ukraina, Rusia, Estonia, Brazil, Bosnia-Herzegovina, Nigeria, Bulgaria, India, China, Germany, France, Italia, Finland, Hungary, Poland, Europe, Barbados, Ghana, USA, St Kitts, England, Trinidad, Japan, Switzerland, Norway, Stockholm, Malmo, Oslo, Bergen, Paris, Marseille, London, Cardiff, Berlin, Hamburg, St. Petersburg, Moscow, Tokyo, Tokyo Narita Airport, Baker Street	71
Science	<Biology> 41 [animal 28]spider, sea cow, water animals, emperor penguin, vulture, bird, tropical fish, blue whale, sea turtle, stork, antelope, E-coli bacteria, eagle, African leopard, human, homo-sapience, dog, fish, perch, mammals, insects reptiles, dinosaurs, cat, Osteichthyes, mosquito, fossil, Homo Habilis [plant 9]blueberry, apple, cucumber, orange, banana, land plants, forests, conifer, flower [others 4]evolution, generation, ice age, pre-Cambria <Astronomy> 25 Mercury, The Earth, vacuum, Sun, cosmos, Big Bang, Solar system, space, planet, galaxy, the Milky Way, star, Moon, orbital, Venus, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto, AU, light year, Andromeda, Proxima Centauri	84

	<Chemistry & Physics> 18 oxgen, mercury, lactose, energy, protein, carbohydrate, fat, calcium, vitamin, amber, temperature, melting point, boiling, light, frost, radioactive decay, frozen point, speed	
Daily life	<Drink & Food> 21 Pizza, Pizzeria, orange juice, apple juice, beverage, soda, cake, pie dough, recipe, bottle, strawberry juice, food, grain, coffee, candy, beef, sirloin, low-fat milk, nutrient, biscuit, sausage <Households> 13 laundry detergent, freezer, stamp, garage, container, cleaning, fleece, fabric, glass, room, board, rope, bath <Sports & Play> 26 diving, soccer, sports, football, ice hockey, physical activity, exercise, sprinter, race, trail, trekking, hiking, jogging, fishing, ski jumper, lure, suncream, rubber boart, swimming, maze, dirts, book, mystery, movie, X box, game <Travel> 39 letter, flight distance, journey, lakeside, exchange rate, dollar, USD, yen, JPY, pound, GBP, Krona, SEK, Franc, CHF, NOK, Ruble, RUR,price, EUR, mileage, travel, height, horizon, vertical, ocean, depth, radius, island, beach, train, airplane, gasoline, taxi, JR, Narita Express, tire, valve, station <Economy> 21 wallet, money, cent, mortgage, Euro, bank, cash, receipt, deposit, purchase, shop, gold, ounce, jeweler, stone, diamond, ruby, emerald, sapphire, trade, European Central Bank <Social> 44 November, week, family, children, crime, mother, father, class, student, house, Police, officer, Rector, the office, suspicion, guilty, surname, bald hair, gentleman, Sunday, pilot, demographics, refugee, population, migration, immigration, birth, death, emigration, young people, aunt, inherit, charity organization, school, scholarship, Red Cross, child right, Sydney Olympic	164

Appendix 3. Contents of a Japanese Mathematics Textbook for First year of Junior High-school published by Kyouiku Shuppan

The number of each title shows its page number which the section bigins

Appendix 4. Categorization of Non-Mathematics Words in a Japanese Mathematics Textbook for Freshman of Junior High-school

Category	Examples		Number of words
Person's name	<Domestic> Aya, Tomoya, Momoko, Taiki	4	4
	<Worldwide>	0	
Place name	<Domestic> Sapporo, Akita, Tokyo, Shizuoka, Osaka, Hiroshima, Takamatsu, Fukuoka, Nagasaki, Naha, Mt. Fuji, Izu, Ogasawara trench, Tokyo tower, Seikan tunnel, Lake Biwa	16	20
	<Worldwide> Japan, Belgium, Rusia, Tunisia	4	
Science	<Biology>	0	6
	<Astronomy> Space shuttle	1	
	<Chemistry & Physics> water level, transparency, water temperature, temperature, sea level	5	
Daily life	<Drink & Dood>	0	31
	<Households> CD player	1	
	<Sports & Playing> soccer, point, points lost, victory or defeat, big jumping rope, magic cells, a 50 meter race	7	
	<travel> road, east, west, route, train, railroad, ticket	7	
	<Economy> bankbook, profit, loss	3	
	<Social> newspaper, Golden Week, crowds estimation, police superintendent, homepage, test, points, supermarket, machinery parts factory, town hall, bank, food factory, post office	13	