The Current State of Japanese Primary Mathematics

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Since the Meiji period mathematics teachers have been instructing the contents using a blackboard and a piece of chalk. And instructional methods have been identical to the traditional ones. Now Japan's education is changing greatly. People want changes in every aspect. Soon the new revised version of the Course of Study (the 6th version) will be issued.

1. The History of Japan's Mathematics Education

With regard to Japan's mathematics education, there are three major transitions.

(1) The first transition

The first transition is the adoption of Western mathematics (Yosan, 洋算 in Japanese) which took place during the Meiji period from 1868 to 1911. In this period, Japan adopted mathematics and spread it nation-wide. In this period, there were many Wasanka (i.e., Wasan mathematicians) in Japan. Wasan (和算) is mathematics indigenous to Japan, which had existed before the Meiji Restoration and whose origin was the Chinese classical mathematics. And there were very many private-temple-schools (Terakoya, 寺小屋 in Japanese). Therefore imported Western mathematics spread quickly. Since 1892, mathematics has been called "Sugaku"(數学) in Japan.

(2) The second transition

The second transition is "Mathematics Education Reform Movement" which took place in the middle of the Taisho period from 1912 to 1925. But scholars such as FUJISAWA and KIKUCHI emphasized the special branches of analysis and logical treatment of geometry. It was in 1901 when this movement began in the world. But in Japan this movement took place 17 years later, in 1918.

(3) The third transition

The third transition is "Modernization of Mathematics Education" which took place during the middle of the Showa period from 1926 to 1988. In 1957, the so-called "Sputnik shock" happened, industrial structures were developed, and the role of modern mathematics became more important. "Modernization of Mathematics Education" rapidly spread worldwide since about 1960. But in Japan's mathematics education, it was in 1968 when the curriculum, that is, the "Course of Study for Elementary Schools," was established.

H. TOYAMA designed the so-called "The Water Supply Method" (水道方式). He laid down the theory of quantity and established the Method based on this theory. This Method met remarkable success in primary schools and is now adopted more or less by all the authorized textbooks for primary schools.

2. Children's School Life

(1) Curriculum standards

Curriculum standards for elementary schools are prescribed in the "Course of Study" issued by the Minister of Education, Science and Culture. The Course of Study provides the basics for curricula, that is, aims of each subject and the teaching content at each grade from the first to the sixth. The revised Course of Study (now in use) was issued in 1989 and went into effect in elementary schools in April, 1992. The revised Course of Study is the fifth revised edition after the Second World War. That is, these versions were published in 1947, 1958, 1968, 1977 and 1989.

The Course of Study now in use was revised on the basis of the following four guidelines:

1. Young people should possess richness of heart and strength of mind.
2. Children's capacity to respond to changes in society, creativity, and the willingness to learn.
3. Learning essential knowledge and skills, and developing full individuality. For them, a consistent curriculum from kindergartens to upper secondary schools.

4. Respect for Japanese culture and traditions, and understanding cultures and histories of other countries. Quality living in the international community.

(2) School hours

Elementary education consists of three areas, namely, "Subjects", "Moral Education" and "Special Activities." The following table shows the standard school hours per year for elementary schools.

	School hours per year					
Grade	I	II	III	IV	V	VI
Subjects	782	840	910	910	910	910
Moral Education	34	35	35	35	35	35
Special Activities	34	35	35	70	70	70
Total	850	910	980	1015	1015	1015

Note: One school hour is defined as a class period of 45 minutes.

School attendance is compulsory for all children up to the age of fifteen. According to the Course of Study (for the 3rd grade), children's time in school is 28 hours per week. That is to say, Subjects occupy 26 hours, Moral Education, 1 hour, and Special Activities, 1 hour. The mean of school time is about 5.1 hours per day.

(3) Learning the content of Arithmetic

We shall omit the details of the Course of Study for Arithmetic or Primary Mathematics. Mathematics, as a subject in elementary schools, is translated as "Arithmetic" in English and is called "Sansu 算数" in Japanese.

It consists of four branches, that is , Number Calculation, Quantities and Measurement, Geometrical Figures, and Quantitative Relation. The overall objectives of Arithmetic are as follows:

To have children acquire the essential knowledge and skills regarding numbers, quantities and geometrical figures, and

To develop their ability and attitude dealing with matters in daily life by logical and rigorous thinking.

(4) The number of school hours for Arithmetic

The Subjects and the number of school hours are prescribed by the Course of Study.

	School hours for Arithmetic per year					
Grade	I	II	III	IV	V	VI
Hours	136	175	175	175	175	175

One year consists of 35 school weeks. Therefore school hours per week is as follows:

	School hours for Arithmetic per week					
Grade	I	II	III	IV	V	VI
Hours	4	5	5	5	5	5

There is the "NHK survey of people's daily life" by Nippon Hoso Kyokai.

Children's daily life per weekday (3rd grade or 4th grade)							
sleeping	eating	learning	traffic	practice	mass media	rest	others
9:03	1:31	7:19	0:45	0:21	2:01	0:19	2:31

and the learning time consists of the following:

Subjects, Moral Education, and Special Activities	5:47
Non-prescribed activities (class meeting, cleaning rooms, etc.)	0:19
Learning outside school (crammer, Juku 塾 in Japanese)	1:13

A great part of the learning time outside school is spent on learning Arithmetic, and also half of practice time is spent on learning Arithmetic. In total, children learn Arithmetic for about 2 hours per weekday.

(5) Textbooks

Children use the authorized textbooks in their schools because in Japan the authorized textbooks should be used in all compulsory education and upper secondary education. The Ministry of Education is responsible for this authorization.

The history of the textbook system can be divided into three periods. With regard to Arithmetic, the first is the authorized textbook system from 1886 to 1904. The second is the national authorized textbook system from 1905 to 1947. The third is, again, the authorized textbook system from 1948 up to now.

After 1969, in compulsory education, textbooks are given to children and pupils free of charge. The Education Boards choose textbooks from the list of the authorized textbooks and supply to the school children.

3. Children's Achievement

(1) Problems: Ratio of correctness and incorrectness

The Third International Mathematics and Science Study (TIMSS) was held in February 1995. The numbers of school children and teachers in the sample are 9,069 (4,517 of 3rd grade and 4,552 of 4th grade) and 289 (188 women and 101 men) respectively.

Problems in TIMSS are useful for international comparisons. We shall separate problems into two classes, that is, classes of easy and of difficult problems.

Easy problem: the proportion of correct answers is more than $(m + \sigma)\%$,

Difficult problem: the proportion of correct answers is less than $(m - \sigma)\%$,

where m = average of the proportions of correct answers,

σ = standard deviation.

In the 3rd grade, $(m, \sigma) = (63.0, 16.6)$, hence $(m + \sigma)\% = (63.0 + 16.6)\% = 79.6\%$ and $(m - \sigma)\% = (63.0 - 16.6)\% = 46.4\%$. In the 4th grade, $(m, \sigma) = (74.2, 17.0)$, hence $(m + \sigma)\% = (74.2 + 17.0)\% = 91.2\%$ and $(m - \sigma)\% = (74.2 - 17.0)\% = 57.2\%$.

We shall introduce the following three problems:

[K2]

$$\begin{array}{r} 6971 \\ +\ 5291 \\ \hline \end{array}$$

Which the following is the answer?

1. 11162 2. 12162 3. 12262 4. 1211162

Correct answer: 12262
Proportion of correct answers: (3rd grade) 87.6%,
(4th grade) 93.4%
Incorrect: (the most) 12162
Easy problem for 3rd grade and easy for 4th grade

[I2]

Which of the following is equal to 0.4?

1. four (四)
2. four tenths (十分の四)
3. four hundredths (百分の四)
4. one fourth (四分の一)

Correct answer: four tenths (十分の四)
Proportion of correct answer: (3rd grade) 52.7%, (4th grade) 71.5%
Incorrect (the most): four (四) (27.5%, 10.7 %)
Incorrect (2nd most): one fourth (四分の一) (16.3 %, 14.9 %)
Difficult for 3rd grade and difficult for 4th grade
* Usually 「10分の4」, 「100分の4」, 「4分の1」 are used.
Children are not familiar with kanji numerals.

[J5]
In order to change each number in List 1 to the number in List 2, what do you do?

List 1 :	10	15	25	50
List 2 :	2	3	5	10

1. Add 8 to each number in List 1.
2. Subtract 8 from each number in List 1.
3. Multiply 5 by each number in List 1.
4. Divide each number in List 1 by 5.

Correct answer: Divide each number in List 1 by 5.
Proportion of correct answers: (3rd grade) 36.4%, (4th grade) 49.2%
Incorrect: Multiply 5 by each number in List 1. (25.5%, 24.9%)
Incorrect: Subtract 8 from each number in List 1. (24.1%, 14.5%)
Incorrect: Add 8 to each number in List 1. (10.7%, 8.8%)
Difficult for 3rd grade and difficult for 4th grade.

(2) Educational achievement test

The Ministry of Education holds the survey of educational achievement to collect the basic data to prepare the new, revised Course of Study. The scores and proportions of correct answers, etc. are not published. Here we introduce a problem. This problem is different from traditional ones. The Ministry of Education searches for new changes.

The 6th grade Number and Calculation (Algebraic Expression)
Formula containing □ and the physical situation

The expression $1000 - 120 \times \square$ denotes various numbers and quantities depending on their situations. For example:

『 The destination is 1000km far from here. One goes towards the destination for □ hours on a train of speed 120 km per hour. How much is the remaining distance? The remaining distance 』 is denoted by the following expression:

$$1000 - 120 \times \square.$$

Consider the physical situation like the above, and describe the part: 『 』 and describe the unit suitable to the situation in ( ).

『

』

is denoted by the following expression:

$$1000 - 120 \times \square \quad (\quad)$$

Types of answers:

1. train → bus, etc.
2. buying something, etc.
   120 yen a notebook, buy □ copies of the notebook, pay 1000 yen. The change?
3. distribution of a thing, etc.
   A string 10 m long, make □ strings 1.2 m long from it. The length of the remainder?
4. velocity of movement
   1000 m to the goal, run for □ minutes with 120 m per minute. The remaining distance?
   1000 m to the goal, □ runners relay, 120 m per runner. The remaining distance?
5. others
   Expressible by $1000 - 120 \times \square$

6. explanation is not complete, and it is $120 \times \square$.
   1000 m to the goal, go on for $\square$ minutes with 120 m per minute. The distance travelled?
   1000 kg of rice, consume for $\square$ months, 120 kg per month. The weight of rice consumed?
7. question only
   120 yen per piece of cake, buy $\square$ pieces. Is the amount 1000 yen sufficient?
   1000 candies, each bag contains 120 candies. How many candies remain?
8. other answers
9. nothing about answer.

4. Designs by Teachers

All Education Boards guide schools to seek for their uniqueness or to build their school with distinctive features. Furthermore, all Education Boards emphasize "Change your school."

(1) A "password" in elementary schools

Thus elementary school teachers give each other a password "Let us get a free hand and create." They create newly devised ideas for instructional methods of school subjects and for school events. Therefore many educational practices are presented at educational study workshops or meetings. At the 78th nationwide meeting for Arith-Maths Education under the sponsorship of the Japan Society of Mathematical Education (JSME), 197 educational practices (10 branches) were presented in 5 - 7 August, 1996. And at the 29th meeting for mathematics education study under the JSME, 108 research papers (19 branches) were presented in 2 - 4 November, 1996. At the meeting, "Gender Branch" was newly established.

(2) Teachers' ideas

We shall introduce some new ideas for instruction. In general almost all schools use fieldwork in which teachers try to instruct Subjects, i.e., Social Studies, Arithmetic, Art and Handicraft, etc.

[Design 1]

Aim: Power of self-thinking and self-learning. (5th grade)
Consider again subtraction. Find the answer of

2305 – 1576 = 729.

Devise your method!

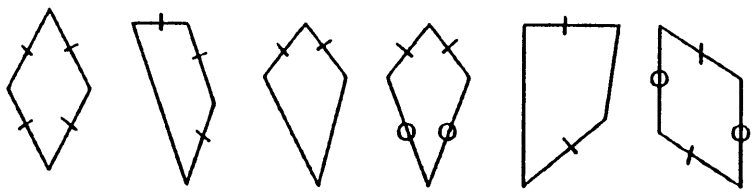
Usually children calculate from the last digit.

2000 – 1576 = 424 424 + 305 = 729 (shopping)
576 – 305 = 271 1000 – 271 = 729 (each digit), etc.

[Design 2]

Aim: Power of intuition and creativity. (4th grade)
Make quadrilaterals with equal sides. Name it.

Example "4 equal sides quadrilateral," etc.



[Design 3]

Aim: Attitude to create various solutions
and to learn from each other. (6th grade)
Devise various methods to calculate

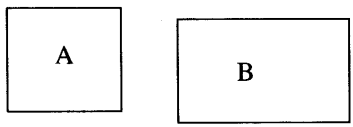
(6/20) ÷ (3/4)

(6/20) ÷ (3/4) = 0.3 ÷ 0.75 = 0.4 = 2/5
(6/20) ÷ (3/4) = (6/20) ÷ (15/20) = 6÷15 = 6/15 = 2/5
(6/20) ÷ (3/4) = (6/20 × 4)÷(3/4 × 4) = 6/5 ÷ 3 = 2/5

(6/20) ÷ (3/4) = 6 ÷ (3/20) ÷ 4 = 2/5
Which method(s) is/are universal? Which is/are more handy?

[Design 4]

Aim: Power of collecting and processing information.
(4th grade)



Consider the area.
Make up problems and solve them.

Measure: lengths of sides and magnitude of angles, problem solving.
Hypotheses: given values of them, problem solving.
Cutting along the diagonals: develop to the area of parallelogram.

[Design 5]

Aim: Ability to communicate with each other. (1st grade)
Addition with carrying.
8 + 6 How many?

1. 2 4 6 8 10 12 14
   ○ ○ ○ ○ ○ ○ ○ making up pairs
   ○ ○ ○ ○ ○ ○ ○
2. ○○○○○○○○○○ ○○○○ rearrangement
   10 4
3. 6 = 2 + 4 8 + 2 = 10 10 + 4 = 14

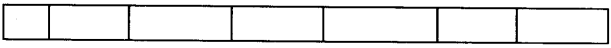
Demonstrate each calculation, explain it and discuss it with classmates together.

* ○ : small disks (Ohajiki, おはじき)

[Design 6]

Aim: Attitude and power to put together learned knowledge items and apply them. (1st grade)

Each child prepares a bar, and makes a body scale out of it. That is,



ankle knee navel shoulder eye head

Measure various things.

Children go out of their classroom, go to the town and measure different things by their body scales.

They recognize that all things outside school are made for adults.

Final remark.

The Central Council for Education has finished consideration and has come to some conclusions, and will soon report the findings to the Minister of Education. Recently change appears in teachers' minds, and self-questioning arises, that is, to ask, "For what purpose do we devise new instructional methods and materials?" Children should gain power for living in the 21st century. Teachers think "Mathematics is power, and mathematics is to be power." "Power in life" and "Mathematics in effect" are becoming their new "passwords."

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