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Japanese Physicist Makita Gotō and Simple Experiments[1]

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Introduction

We report our trial of reviving the simple physics experiments, which were conducted in the classrooms of elementary schools almost all over Japan more than one hundred years ago. The characteristics of simple physics experiments were :

1）teachers used everyday materials
2）teachers used the teacher's own hand-made devices if necessary (not to use ready-made materials)
3）teachers had low cost
4）teacheres did not need high technology.

We believe that simple physics experiments are very effective in physics education in modern-day Japan as well as in developing countries in Africa. In the plenary lecture of the opening day of the ICPE 2007, Dr Priscilla W. Laws introduced us to the value of simple physics experiments, especially for African developing countries. We believe that modern-day Japan also needs these simple physics experiments.

Simple Physics Experiments and Professor Gotō

So-called simple physics experiments in elementary education appeared around 1885 in Japan. Japan was one of the developing countries at that time, and the Japanese government was trying to make Japan a modern state. That was the background of the widespread use of simple physics experiments all over Japan.

Photo 1[2)]

The leader of the movement to introduce simple physics experiments was Mr. Makita Gotō[1)] (photo 1) who was born in 1853 and passed away in 1930. Makita Gotō studied Western learning and graduated from Keiō Gijuku (now Keio University) before 1875. He conducted researched in physics at Glasgow University from 1888 to 1889 and attended a handwork course at Nääs in Sweden in 1888. He became a professor of the Tokyo Higher Normal School (Now Tsukuba

1 This paper was originally presented at the International Conference on Physics Education 2007, which was held on November 15, 2007 in Marrakech, Morroco, and was rewritten for a conference journal that was proposed, but never published.

University), which was established in 1886.

He was well-known for spreading his idea of simple physics experiments all over Japan. Around 1900 it was recognized that the nationwide spread of simple physics experiments in elementary schools was his achievement.

Attractiveness of Simple Physics Experiments

When we studied the simple physics experiments of that period, we felt that there was something attractive about them which we have forgotten in modern classroom physics. Therefore we tried to re-create simple physics experiments from Gotō's textbook for elementary school pupils in order to find out why they are appealing.

We focus on the textbook named *Physics Book for Elementary School Pupils* which he wrote with three of his former students in 1885. The simple physics experiments in that textbook have the characteristics of using everyday Japanese materials such as bamboo.

There were few manufacturing companies which supported the physics experiments in elementary schools because Japan was a developing country at that time. Simple physics experiments were adequate to meet the demand of the level of Japan at the time.

Physics Book for Elementary School Pupils was one of several textbooks of simple physics experiments which were published around 1885. But it was a really epoch-making physics textbook because its contents were based on the authors' teaching experiences in elementary schools and it was not a translated version of European or American physics textbooks. It was written for elementary school pupils of around 13 years of age. Its ways of explanation were based on simple physics experiments in which everyday items were used. Gotō *et al*. adopted a qualitative rather than a quantitative approach.

The structure of the contents was as follows: Part 1 Movement and Force; Part 2 Liquid; Part 3 Gas; Part 4 Sound; Part 5 Heat; Part 6 Light; Part

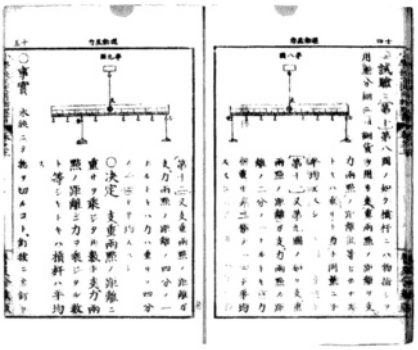

Figure 1

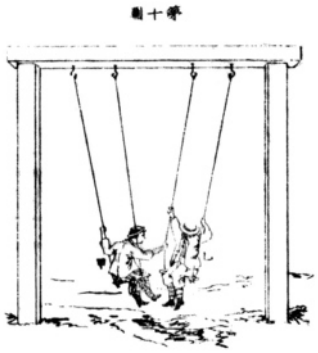

Figure 2

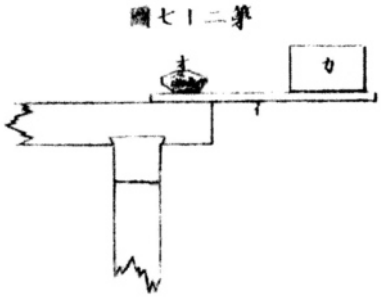

Figure 3

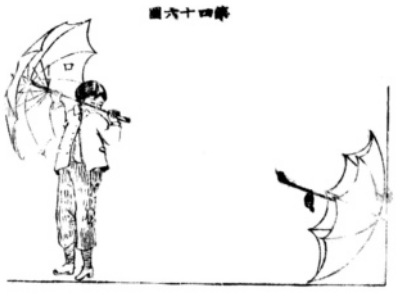

Figure 4

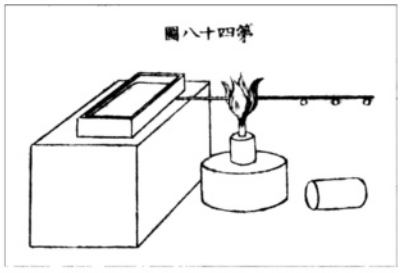

Figure 5

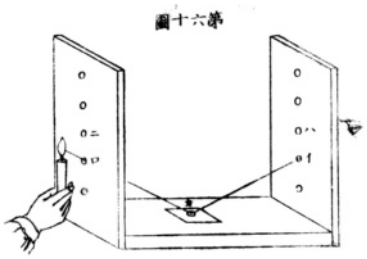

Figure 6

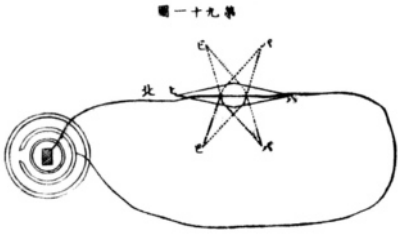

Figure 7

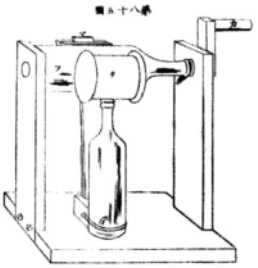

Figure 8

7 Magnets; and Part 8 Electricity. There are some figures in the textbook. Figure 1 explains an experiment on balance which appears in the textbook. Figure 2 explains an experiment on action and reaction. Figure 3 explains an experiment on the weight of carbon dioxide. Figure 4 illustrates the reflection of sound. Figure 5 illustrates the conduction of heat in which three beans drop one by one as heat is applied. Figure 6 shows the straightness of a light ray. Figure 7 shows the influence of an electric current upon a magnet. Figure 8 shows how to make a simple electrostatic generator.

Although it had excellent features, it did not become widespread because the national curriculum was changed just after it was published. However, under the new curriculum, Gotō spread his idea of simple physics experiments.

Some Results of Our Trials

We found opportunities to conduct the simple physics experiments in front of elementary school pupils.

Photo 2 shows our experiment in a public elementary school science class in 2005. Photo 3 is a scene showing pupils conducting the experiment on balance. We used a bamboo scale, coins, a bottle, a cork, strings, etc. to make the device. One coin is on the right side, two coins are on the left side. The original figure in the textbook is Figure 9.

Photo 4 shows our experiment to find out the weight of CO_2. We used a paper bag, string, chopsticks, etc. Carbon dioxide was put into the small bottle. Figure 3 is the original figure.

Photo 5 shows Gunma University's annual Science Fair. We participated in the fair in 2005 and 2007 to conduct a simple physics experiment in front of children. Photo 6 shows our experiment on balancing of weight and buoyancy. We put the picture of the quiz in Photo 7 on the wall, because Figure 9 in the textbook does not explain it precisely. Photo 8 shows a scene in which one of us (Mr. Akabane) explains the phenomenon to school children.

Our Opinion

The simple physics experiments which were

Photo 2

Photo 3

Photo 4

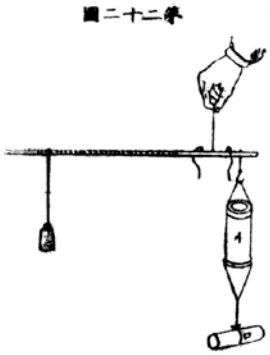

Figure 9

Photo 6

Photo 5

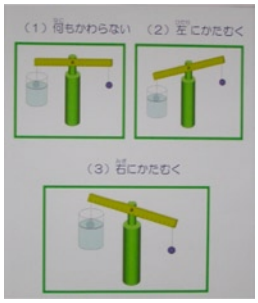

Photo 7

Photo 8

devised more than one hundred years ago were more attractive to children than we expected. However, they were devised and created so that Japan could accept European science ideas when Japan was a developing country. Therefore, we may find they have different values now from what Japanese physicists found more than one hundred years ago.

We feel that their simplicity is still effective now when children try to understand the essence of physics phenomena through physics experiments, and that the handicraft activity of making the experimental devices (the devices are not ready-made) is still now attractive to pupils in elementary and junior high schools.

Ready-made devices for physics experiments are widespread now in elementary and junior high schools throughout Japan. After we experienced conducting the simple physics experiments with school pupils, we doubt the effect of using modern apparatus. We now feel that such modern devices are like toys which automatically work by themselves. Can they arouse the pupils' real interest in physics and make pupils realize the fundamental concepts of the subject?

We have now decided to insist that we should

revive the simple physics experiments in elementary schools again. It seems even more necessary for developed Japan to conduct the simple physics experiments than for pre-developed Japan.

Reference

1）For the career of Makita Gotō, see Mayumi Fukushima (1970, 1971), "Gotō Makita — Meiji kaika ki no rika kyōiku sha [Gotō Makita : Science Educator During the Era of Cultural Enlightenment in the Meiji Period]", *Butsurigaku-shi Kenkyu*, Vol.6, No.3, pp.1-35, Vol.7, No.1, pp.23-56

2）The homepage of the Archives of Keio University.

（しょざわ　じゅん・たかはし　ひろし・あかばね　あきら
たまき　とよみ・たきざわ　としはる）