

Development of Design Education Method Using Passive Walking Paper Robots in Elementary School

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Abstract- The technical education in elementary school education of Japan is very late. It is not installed as a subject. The chief aim is placed by raising sensitivity although there is a scene which makes a thing in arts and crafts. Therefore, schoolchildren make by trial and error in many cases, when making a thing, and schoolchildren do not do design. Then, we developed the education method which gives design specification in order to make the procedure which makes a thing study after design. Since importance was attached to a design, the teaching materials which can perform manufacture easily were developed. By the design based on the use given by this education method, it comes to learn the view of making a thing. When the schoolchild was made to actually manufacture the teaching materials based on a design, the feeling of the achievement which carried out craftsmanship was acquired.

Moreover, the action which a schoolchild is going to bring close to target specification quickly was able to be observed.

Keywords – Design Education, Passive Walking Paper Robot, Elementary School

□.INTRODUCTION

Japan has been implementing the science and technology policy which stood on the long range perspective from 1996 by the "Science and Technology Basic Plan", was systematic and consistent. The plan has described the necessity of being familiar with the fun of craftsmanship from a schoolchild's time consistently. Japan has decided upon the 4th "Science and Technology Basic Plan" now. Raising the concern from an elementary secondary education stage to science and mathematics is shown by the plan. Bringing up many schoolchildren who like science and mathematics is shown by the plan. Unearthing a juvenile schoolchild with the outstanding genius is shown. Promoting the measure which cohered for developing the talent is shown. Moreover, it is said that the social tendency which respects the capability about craftsmanship fundamental technology in a "craftsmanship fundamental technology organic act" is brewed. Promotion of the study about the craftsmanship fundamental technology in school education and social education including the substantial education about the technology in an elementary school, a junior high school, etc. is described.

There is little research on the technical education of an elementary school. Suzuki conducted the children's job breakdown. He showed clearly that the child who makes a highly complete work for a short time has sequentiality in work [1]. However, it was difficult to perform craftsmanship which took in the scientific element in an elementary school until now. The new subject "department of MIRAI creation" which let elementary-and-junior-high-schools

nine years pass in 2012 in the Ministry of Education, Culture, Sports, Science and Technology pilot school for research purposes was founded. Moreover, considering in the government guidelines for teaching that arts and crafts are a subject relevant to the department of junior high school technology was specified. The environment where the teacher can perform the lesson also in recent years and an elementary school centering on craftsmanship is ready in Japan.

The necessity for the consistent technical literacy in an elementary school and a junior high school is taken up in such a situation even in the Japanese Society of Technology Education. The report of research for a schoolchild occurs also in a technical journal. However, for the technical literacy in a long-term viewpoint, the contents connected from elementary school education to a university are required. Moreover, in order to study craftsmanship, design processes, such as a concept, a design, manufacture, evaluation, and an announcement, are important. The education about the present craftsmanship aims at studying the theory of natural science, or although many give the pleasure and sense of accomplishment of craftsmanship, there are few teaching materials which are going to make it study the design process itself. It is thought that the processes in which it results from a concept to a design are the foundations of craftsmanship, and are the technical literacy which should be put on from elementary school education.

II. PASSIVE WALKING PAPER ROBOT

Authors have so far studied many passive walking paper robot which a schoolchild can also manufacture happily easily[2]. We can make it walk along passive walking paper robot only by gravity, without using a motor, a sensor, and no computer. A schoolchild has interest why to move and is concerned about signs that he walks lovely. However, there were also scenes of taking time in manufacture, such as a mechanism of a link, in an elementary school low grade. Then, Authors propose the simplest passive walk model made of paper that will be made if there



Figure.1 Passive Walking Paper Robot

are paper, scissors, and paste for elementary school of every country in the world to which a schoolchild low grade, or a tool or a machine tool are not equal. The passive walking paper robot made develops manufacture as teaching materials for making the process in which it results from a concept to a design from the first study. The developed passive walking paper robot made is shown in Figure. 1.

□ THE CONCEPT FOR DESIGN EDUCATION WHICH USES THE PASSIVE WALKING PAPER ROBOT

Also in an elementary school low grade, passive walking paper robot is the feeling of a paper craft by turning off and assembling a paper pattern, and can do easy craftsmanship. Moreover, passive walking paper robot walks a slope certainly.

Also as for the pleasure and sense of accomplishment of craftsmanship, a schoolchild is obtained.

We show the portion in which a schoolchild may be able to change the parameter related to movement of a model freely in a paper pattern in Fig. 2. One is the length l of a leg and another is the angle θ at the bottom of a

leg. Although we can consider many parameters of movement, these two parameters can be changed easily and, moreover, their influence on movement is great.

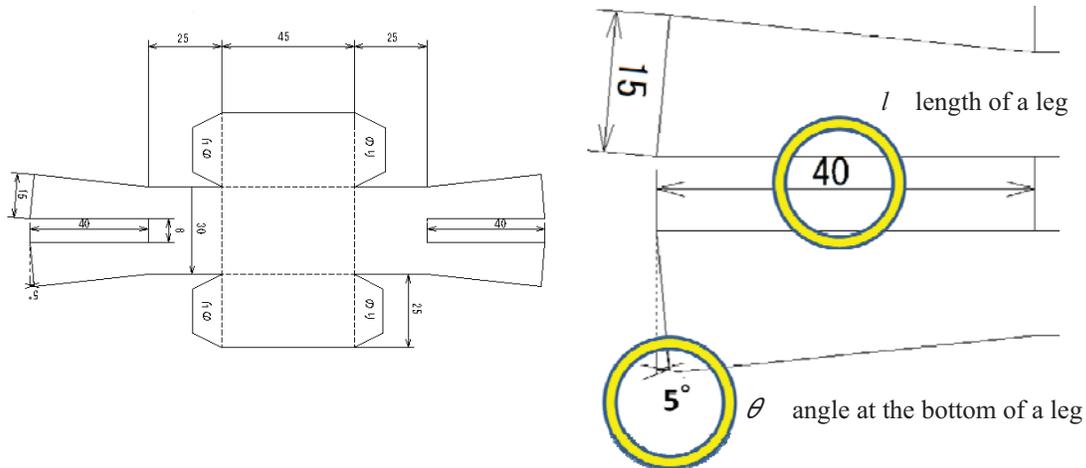


Figure.2 The Parameter Which can be Changed in a Paper Pattern

The walk state in which it experimented on various conditions is shown in Table 1. The angle of a downhill, and the length l of a leg and the angle θ at the bottom of a leg were changed.

"▲ is walked very slowly. △ is walked slowly. ○ is walked at an ordinary speed. × is without walk."

The value of the parameter for making it walk slowly from this table or the parameter for making it walk ordinarily is known. The design specification "make the model which walks slowly" can be considered as education method of design education. The schoolchild can study the flow of the craftsmanship of designing from a concept, by manufacturing a model by the design based on design specification by the ability to give design specification. For example, in order to make it walk slowly, you have to set the angle θ at the bottom of a leg as 5 degrees. The length of a leg must be changed depending on the angle of a downhill.

Table.1 The Walk State at the Time of Changing the Length of a Leg, and the Angle at the Bottom of a Leg

angle of a hill $\Phi [^\circ]$	$\theta = 5^\circ$			$\theta = 7^\circ$			$\theta = 9^\circ$		
	$l = 20\text{mm}$	$l = 30\text{mm}$	$l = 40\text{mm}$	$l = 20\text{mm}$	$l = 30\text{mm}$	$l = 40\text{mm}$	$l = 20\text{mm}$	$l = 30\text{mm}$	$l = 40\text{mm}$
7	x	x	x	x	x	x	x	x	x
8	x	x	x	x	x	x	x	x	x
9	x	▲	x	x	▲	x	x	x	○
10	x	▲	○	x	○	○	x	x	x
11	x	△	○	x	○	○	x	x	x
12	▲	△	○	x	○	○	x	○	x
13	▲	○	x	x	○	x	x	x	x
14	▲	○	x	x	○	x	x	x	x
15	▲	x	x	x	○	x	x	x	x
16	▲	x	x	x	x	x	○	x	x
17	○	x	x	x	x	x	x	x	x
18	x	x	x	x	x	x	x	x	x
19	x	x	x	x	x	x	x	x	x

□ The Result of Practice

In December 2013, at the Science Center of Shiga Prefecture, the subject which makes the robot which walks most slowly to ten schoolchildren (first grade, second grade, third grade) was taken out, and the paper pattern was given.

As a result, it was all schoolchildren that manufactured as the paper pattern and completed the robot. After discussing by ten persons after that, it separated to the schoolchild who lengthens a leg, and the schoolchild who shortens a leg. Three of ten persons completed the robot which walks slowly. Schoolchildren's comments are shown in Table 2.

That a schoolchild can also give design specification and can make a thing make understood.

Table. 2 Some Schoolchildren's Comments

- | | |
|---|--|
| 1 | The regular thing was not made, but it was good to think. |
| 2 | I got the friend to teach the method along which it is made to walk. |
| 3 | I felt that the thing was made, although it was easy. |

Schoolchildren's comments showed that the children's sense of accomplishment was increasing by giving design specification.

V.CONCLUSION

The passive walking paper robot made of was developed as teaching materials for making the process in which it results in a design education. It was shown that there are the length of the optimal leg for design specification and the angle at the bottom of a leg. With the education technique based on design specification, the student can study technology literacy.

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