Educational Methods Using the Passive Walking Paper Robots for Teacher Education

Tetsuya YAMADA
Graduate School of Education Cooperative Doctoral Course in Subject Development, Shizuoka University
Shizuoka-Shi, Shizuoka, Japan

Kimihito TAKENO
Faculty of Education, Shiga University
Otsu-Shi,Shiga,Japan

Yasuhiro MATSUNAGA
Faculty of Education, Shizuoka University
Shizuoka-Shi, Shizuoka, Japan

Abstract- In Japan, science and technology education has become more important in elementary school. As teaching materials for elementary or junior high school, we developed a passive walking paper robot. Elementary school students can adjust the walking speed by changing some of the robot's parameters. In this study, the students in a teacher training course made paper robots, and the education method provided in the design specification of "the department teaching methods of technology" was enforced. They discovered some parameters related to the motion of the robots, and considered various lesson deployments using the paper robot.

Keywords – Education Method, Design Specification, Teacher Education

I. INTRODUCTION

In Japan, young people's volition to study science and technology is decreasing. The aversion to craftsmanship has not stopped. This is also starting to have a large influence on our industrial society. Technical education is related to this social problem through the aspect of industrial education. Technology education has a large influence on learning design abilities to meet human needs. In other words, technology education supports Japan as a technology nation, and it may be said to even have an influence on the future strength of the nation. At present, junior high school handles this technical education as part of a general education in Japan, treating it as technical area and part of home economics. From the viewpoint of acquiring the minimum technical quality for the healthy development and life of a child and the viewpoint of the future strength of the nation, we investigated a new manufacturing education method for an elementary course. In addition, the technical education curriculum for secondary education is also thought to be important. Kolodner,J.L. gave necessity with a design to in "Science" and advocated "Learning by Design"[1]. There has been little education content and few methods to raise the technical quality of the conventional elementary school curriculum. Few studies have been conducted on technical education in elementary school. Suzuki［2］ worked with children and analyzed it, and a child who produced an extensive amount of work in a short time clarified that there were order characteristics for elementary operations. Suzuki is doing development of teaching materials for elementary school technology education. However, there are few teaching materials for performing technologyl education in an elementary school. Therefore, we aimed to develop teaching materials for technical education that could be utilized in an elementary school. The purpose of this study is development of the teaching materials by which a teacher can find education methods for technical problem solving. We studied a bipedal passive walking robot [3]，[4] and a passive walking paper robot [5]. We developed the robot shown in Fig. 1 and elicited comments

from undergraduates. We have developed teaching materials of bipedal walking robot from the preceding study. We have confirmed the validity of the teaching materials. We considered to use it for teacher education to utilize more these teaching materials effectively. It's important for them to know and experience more teaching materials for a student of teacher education to become a teacher. When they became a teacher in particular, We can think it's very useful.

II. PASSIVE WALKING PAPER ROBOT

We developed passive walking paper robots that even a primary schoolchild could easily produce. A schoolchild is interested in how a robot moves. They are concerned about the path along which the robot walks. This robot greatly differs from previous passive walking robot teaching materials because it can be manufactured using only scissors and paste. Thus, it is not necessary to process the material using a difficult machine tool at an elementary school. The schoolchild can experience the craftsmanship of manufacturing while concentrating only on the procedure of craftsmanship from the concept to design. The passive walking robot walks by supplying potential energy. A robot shakes to the right and left, and walks. The width is determined when the leg changes by the load at the time the grounding leg is released from the load, and the idling leg takes one step of a walk and then returns to the original form.

Fig.1 Passive Walking Paper Robot

Modification of a leg gradually increases the axle weight P, where the former bending is given to the long and slender leg, by which an end fixation and simple support on the other end are carried out, until it reaches a certain value (buckling load). When it is brought close, it is in the state from which the balance of power occurs in the state where it changed. We show this state in Fig. 2.

That is, if length l of a leg becomes large, one step of the increase in the maximum bending δ and the step will become large. The walking rate can be adjusted only by the length of a leg. Moreover, the cycle of right-and-left vibration changes by adjusting the angle of the bottom of a leg. An element related to the walking rate can be found.

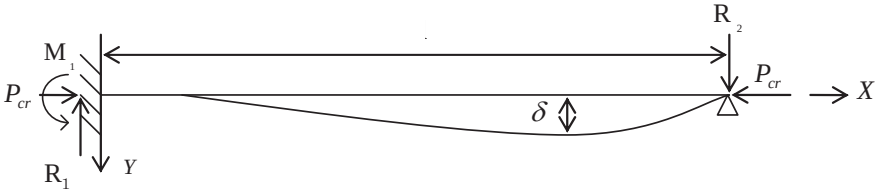

Fig.2 Severe Deflection of Grounding Leg

A passive walking paper robot made of paper was developed as teaching materials for design education. It was shown that was an optimal leg length for the design specification and the angle at the bottom of a leg. The student can study technology literacy using an education method based on design specification [4].

III. LESSON PRACTICE

A lesson that used a passive walking paper robot was conducted in June, 2014, as part of "the department teaching methods of technology" of a university. Eight students participated. The flow of the lesson is listed in Table 1. The student was made to recognize what to study first. The target of this study was control of a passive walking robot. Next, the walking methods used by various robots seen in everyday life were considered. Here, how an old robot or the present robot walks was shown to the students using images. An image of the passive walking robot manufactured at this time was also shown, and the study choices were considered. The student manufactured the passive walking robot with the selected form. The walking speeds were all the same in order for all the students to manufacture robots with the same form. Then, the design specification was given to the student. The design specification was used to manufacture the slowest walking robot. A student repeated an experiment by changing the length and form of a leg. When the experiment concluded, they divided into groups and exchanged opinions. A student reported on the experiment that he conducted.

The students filled out questionnaires about the parameters that they finally discovered and the education method for invention. The experimental session is shown in Fig. 3.

IV. EXPERIMENTAL RESULTS

The students were able to find some parameters related to walking. The parameters that had two or more comments among the parameters that the student found are listed in Table 2. The parameters in this table are directly and indirectly related to walking. It was also a great discovery for us that the students could discover some parameters. Moreover, the student learned some things about how to teach through this lesson. Even though the passive walking paper robot was suitable for teaching the lesson, it turned out that the students had two different views. First, it was proposed that the principle of a walking robot be considered first. Others proposed that the design route for walking be considered. The student's typical opinions are listed in Table 3. Opinions were 3 type. The opinion was piled. Therefore other opinions indicated 3 opinions as a typical opinion.

Table 1 Manufacture of Quadrupedal Passive Walking Paper Robot Educational Guidance Proposal

Learning activity / Contents	Important points for activity and instruction	Form	Time (min)
Presentation and explanation of a self-valuation sheet	Student gains an understanding of self study for control of a passive walking robot.	Simultaneous	5
1. Various robots	How various robots seen in everyday life walk is considered.	Presentation	15
2. Setup of craftsmanship environment	A regular model is created.	Individual	20
3. Design specification is given	Each student examines a different parameter.	Individual	30
4. Discussion	A discussion is conducted and the factors related to the motion are listed.	group	10
5. Presentation	The result is released for every group, and the manufactured product is evaluated.		
Advice for optimization in craftsmanship	Free description sheet entry.	Individual	10

Fig. 3 The Situation of the Experiment

Table 2 Parameters Discovered

The length of a leg (5 students)
The angle at a tip (3 students)
A robot's weight (2 students)
The angle of a hill (2 students)
The coefficient of friction of a hill (2 students)

Table 3 Students' Typical Opinions

・The length of a suitable leg for a robot to move slowly and the angle must be known.
・The goal of learning is discovering that the walking rate can be changed. In order to carry out the work, the walking principle must be understood. A better robot can be constructed by trial and error.
・If I have a classroom full of schoolchildren, I will use this method to make a robot. I think that a schoolchild will gain an understanding through hands-on experience. If I have a class of junior high school students, I think that will be necessary to simply think about why the robot walks slowly.

Six students proposed the lesson on the walking principle. However, two students proposed a lesson on the route of the design. Discussing the walking principle could be done in a science class. Although the walking principle is important, technology education may require a lesson on the route of the design.

Changing the robot's structural parameters was a new proposal. It turned out that the student who suggested the lesson on the route of the design also considered how it appeared.

V. CONCLUSION

We showed that some parameters related to motion were found when a student changed a robot's structural parameters.

Developed teaching materials showed that the teacher is able to find many parameters related to a movement. When solving problems technically, this thing is very important. Even in addition to raising the ability of the teacher, the teaching materials for which a teacher can find an education methods are significant.

Moreover, among the students, those who proposed a lesson on the route of the design for walking also considered how it appeared. It became clear that the education technique of providing the design specification was one method of teacher training for elementary school education.

One example by which a teacher can educate the problem solving type was indicated by developed teaching materials. We could develop the teaching materials by which a teacher solves problems technically.

REFERENCES

[1] Kolodner J. L. , (2002), ”Learning by Design : Iterations of design challenges for better learning of science skills, ”Cognitive Studies,9(3), 338-350

[2] Suzuki,T(2004) : An Analysis of Students’ Work in Object-making Class in Elementary School(in Japanese), Journal of the Japanese Society of Technology Education, 46(1), 25-31

[3] Suzuki,T(2013): Teaching-materials development of the Technology Education in an Elementary School, Chiba University study bulletin,61,145-153

[4] Yamada,T. Kuratani,F.(2006) : A Study on a Bipedal Walking Model as a Teaching Material for Object-making in Elementary and Junior High Schools- (in Japanese).Journal of the Japanese Society of Technology Education, 48(3), 84-93

[5] Yamada,T. Kuratani,F.Maeda,H:Education Method to set the Structure Parameter of a Bipedal Walking Model for Teaching Material(in Japanese). Journal of the Japanese Society of Technology Education, 55(1), 35-42

[6] Yamada,T.Maeda,K.Matsunaga,Y(2014) : Development of Design Education Method Using Passive Walking Paper Robots in Elementary School, International Journal of Innovations in Engineering and Technology, Special Issue JTL-AEME