

Development of an Animation Making System for Students to Represent Dynamic Phenomenon

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Abstract: We develop an animation making system called "Galop" for students to understand about phenomenon in the science education by expressing dynamic models. To express the dynamic phenomenon, students can easily make animations by using Galop. Through the animation making process, students think compared with the objects moving in the animation and understand the phenomenon. This paper describes our system design and development.

Keywords: Drawings, Science education, Repeat-playable-drawing system, Animation making, Galop

Introduction

It is general that we express our concepts and ideas using drawings and figures to reorganize or reflect our thought. Recently, a lot of computer systems for assisting reorganization and reflection of human thought have been proposed and developed. We especially focus on Drawings [1-4] in science education as a target domain to investigate assistance of reflection using the above-mentioned way, and developed "Polka"[5]. Polka assists students to draw and edit scientific model as the combination of plural abstract figures and to reflect their drawing processes using the playback function.

Thorough several educational use of Polka in classes, we found that it is hard for student to express dynamic images including movement of objects or phenomenon by using Polka. For expressing dynamic images of students, we develop an animation making system called "Galop[6]". Student can represent various kind of phenomenon (water evaporation, electric current, and so on) by using Galop.

1. Related Works

Concept Map and Drawings are representative methods to assist reorganization and reflection. Reflective Mapper called "Ando-kun" is one of educational tools for Concept Map[7]. Ando-kun can show the construction history of concept maps. In other hand, "No-no-Kagami"[8] is a digital paint tool which can be used for Drawings. Naruo et al. [9] investigated children's naive concepts and thinking processes about an electric current using "No-no-Kagami". In their investigation, children drew models of the electric current and explained their concepts using the models. Through this investigation, they confirmed the educational effectiveness of "No-no-Kagami" for drawings.

2. Background of System Development

Drawings

In science education, children learn many things through observations and experiments about nature objects and phenomena. They might learn common features of target objects through their observations. They also might find mechanisms behind the observable phenomena. These common features and mechanisms of the objects and phenomena are regarded as nature rules and models. For example, "Learning of Insect" substantially focuses on children's understanding of common features of many kinds of insects but not only individual features of each species. For other example, "Learning of Combustion" emphasizes on children's understanding of behaviors of invisible oxygen and carbon dioxide in combustion phenomenon. "Drawings" is a popular way for such science education. Children usually draw observation objects or invisible things behind phenomena in Drawings. For example, children might understand the common features of insects through drawing the insects they observed.

In learning of science phenomena, teachers can make their students to draw their predictions for explaining their hypotheses before experiments and then draw figures enable to explain observed phenomena after the experiments. In addition, children understand the target objects abstractly, and predict and explain the target phenomena based on their own drew models in learning by Drawings. We define "learning of scientific model" as "learning assisting children to enable to represent nature objects and phenomena as abstract models and to predict and explain about them based on their models". We also focus on Drawing as a proper way for learning of scientific model. In the viewpoint of learning process, it is typical that children convert target objects and phenomena to abstract figures (basic figure objects) and then explain the targets using their abstract figures.

Repeat-Playable-Drawing System "Polka"

We developed "Polka" as a drawing system for science education with Drawings. Polka has the following functions:

- (1) drawing basic figure objects (circle, rectangle, polygon and so on),
- (2) drawing lines and free lines,
- (3) text input for additional explanation and comments,
- (4) duplicating same objects easily,
- (5) editing drew objects (move, delete, and so on), and
- (6) memorizing all of drawing processes and playback of the processes.

As for (1) to (5), Polka has similar functions of common drawing systems. The function (6) is special feature of Polka which supports Drawings.

In other view point, Polka was also developed as a Repeat-Playable-Drawing System. Polka has two significant features: (1) figure management using vector data, and (2) playback of drawing process. All drawing processes can be identified as editing operation of basic figure object in Polka. Students can check their drawing process by playing these processes step by step. Through playing drawing processes, students can reflect their thinking process.

Fig. 1 shows the interface of Polka. In design of Polka's interface, we classify Polka operations into the following three modes:

- (1) drawing figures: for setting basic figure objects on drawing area
- (2) editing figures: for changing figure attributes, move, and deletion, and
- (3) playback of drawing process

Polka provides three-mode interface according to the classification. We call these three modes "draw mode", "edit mode", and "playback mode". Children can draw figures in "draw mode", edit them in "edit mode", and confirm their processes in "playback mode".

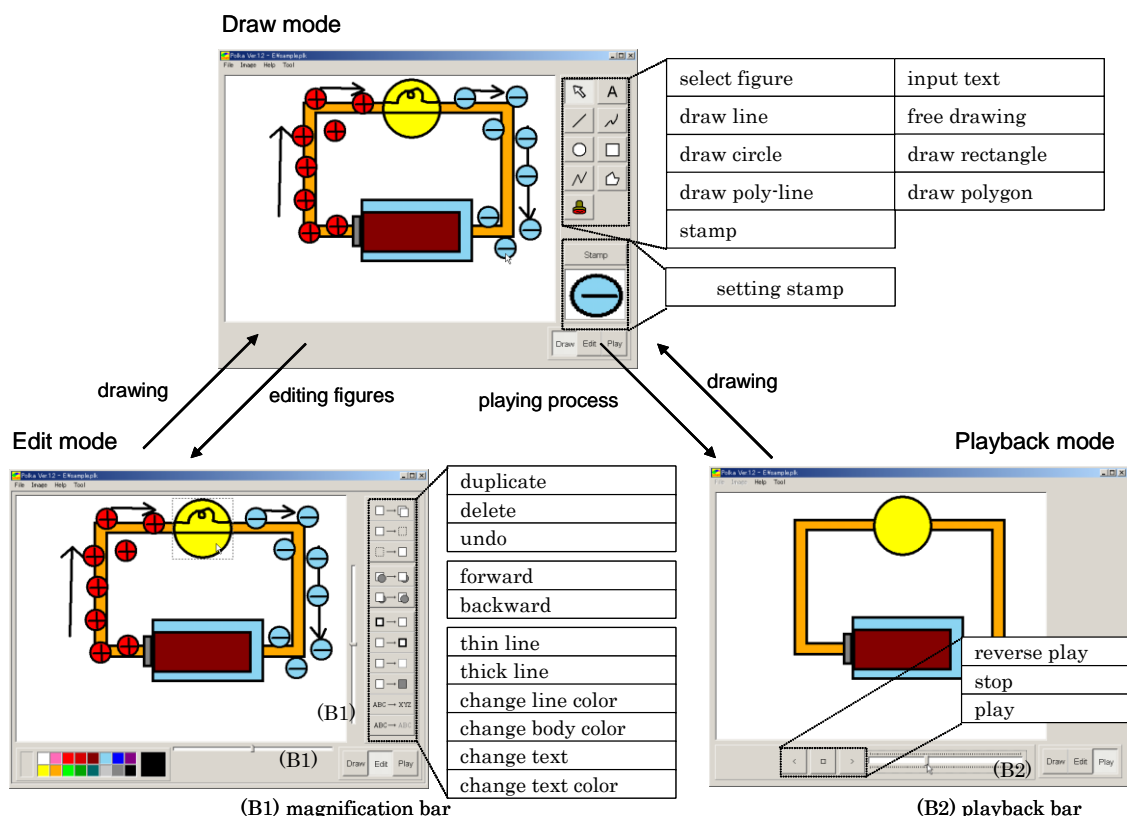


Fig.1. Interface of Polka

Polka and Dynamic Phenomenon

Through several educational use of Polka in classes, we found that it is hard for Polka to express dynamic images including movement of objects or phenomenon. Fig. 2 shows the state of affairs of hydrogen combines to oxygen and becomes water. For expressing this chemical reaction, adding the arrow that shows the passage of time is needed in the figure.

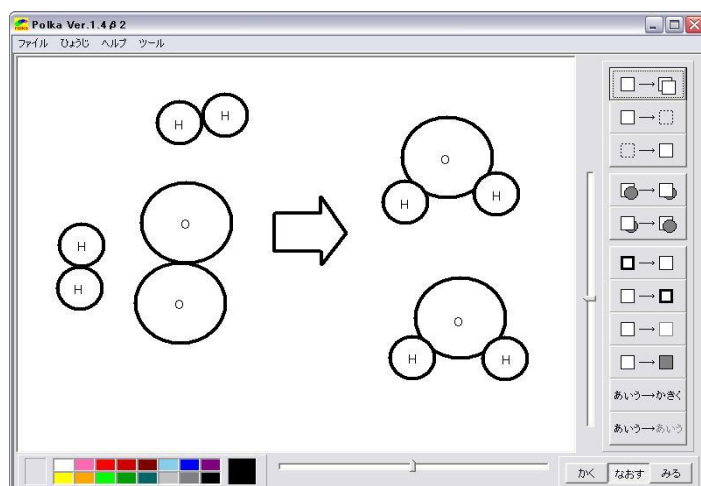


Fig.2. Chemical reaction of water on Polka

3. Galop: Animation Making System

Needs analysis about making animations for science education

We obtained five representative opinions by teachers who used Polka in their classes. Their opinions are in the followings:

- (1) Some children enjoyed moving figures by using "Play mode" of Polka.
- (2) Polka could be used as an animation tool for expressing the change of the phenomenon in some science classes.
- (3) If Polka is used for making an animation, some needless scenes remain or it is difficult to revise the animation.
- (4) If a simple animation system for the science class is developed, they wanted to use it.
- (5) Simple animation tool is expected that preservation of revision record and indication of revision process, similar to Polka.

We have also investigated needs from teachers of science education for design and development of Galop. Through the investigation about needs of teachers and the analysis, we decided the function Galop should provide. The functions are in the followings:

- (1) Object drawing function to draw in model
- (2) Color change function to express that passage of time of model
- (3) Animation function to move model and arrow, and to express dynamic phenomenon
- (4) Function to leave afterimage while moving (drag) model
- (5) Function that selection of the arbitrary model can easily if overlaps models.
- (6) Function that the object moves on drawn with the mouse.
- (7) Automatic reproduction function that speed can be specified.
- (8) Correction function of animation

How to make animation

The number of work processes to make animation provided by Galop should be reduced and be easy for student to understand the method. Therefore, general animation making method that making all animation scenes one by one is not suitable. We use "cut" for making animation in Galop. First, a student locates objects in a cut (start status). And then, s/he moves them or adds several effects (end status). After this process, Galop automatically generates animation between the start status and the end status. For realizing this function, each cut has location and effect data of start and end status shown in Fig. 3. Animation making by cut is easy for student to use and understand.

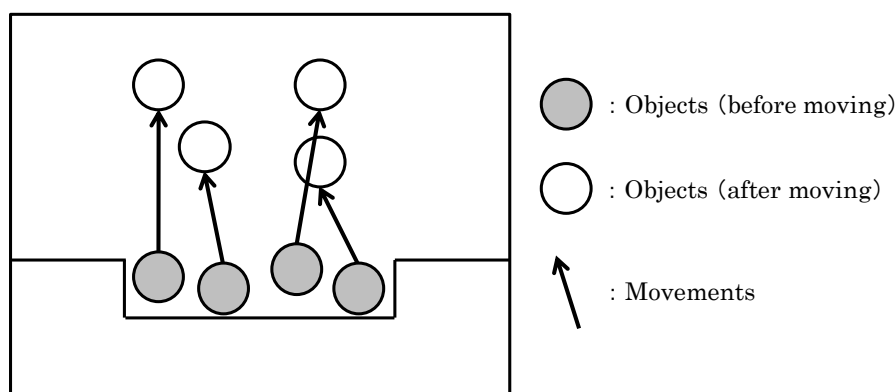


Fig. 3. Information of "cut"

Interface of Galop

There are two operation modes called “Making mode” and “Animation mode” in Galop. Students can make animation by coming and going between making mode and animation mode. Making mode is for student to make animation in cuts. In this mode, students can locate figure objects, edit them, and set cuts. Fig. 4. shows a snapshot “Making mode” of Galop. In addition, Students have to prepare figure objects which they want to animate, before making animation. Galop can read figure object data created by Polka and edit each figure object shown in Fig.5.

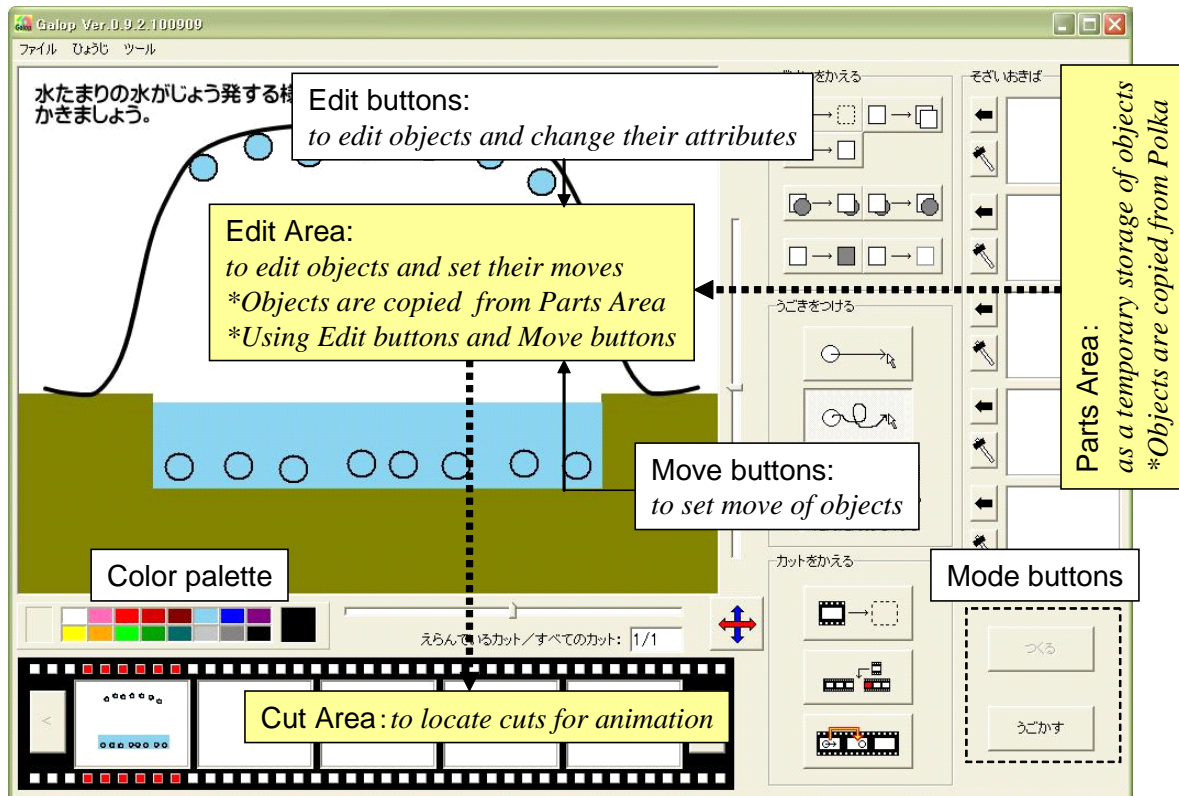


Fig. 4. Making mode of Galop

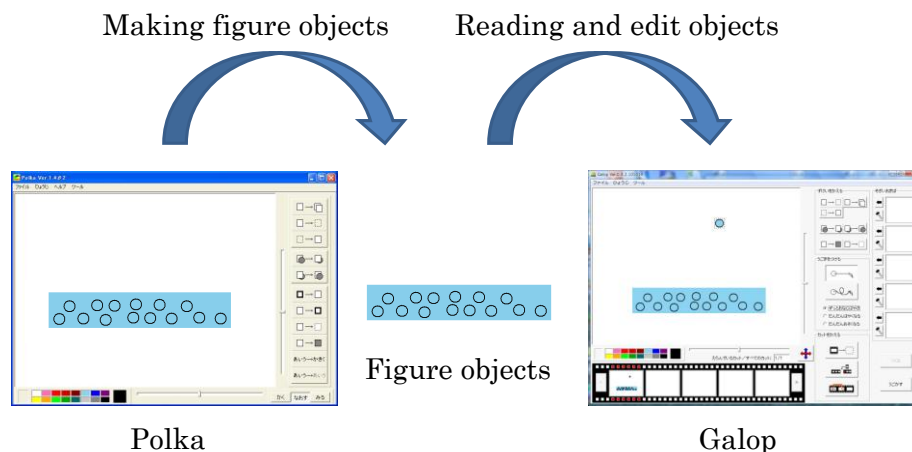


Fig. 5. Figure data transmission between Polka and Galop

Animation mode is for show animation based on cuts set by students. There are two types of animation: “one cut animation” by one cut and “all animation” for all cuts. Fig. 6. shows a snapshot “Animation mode” of Galop.

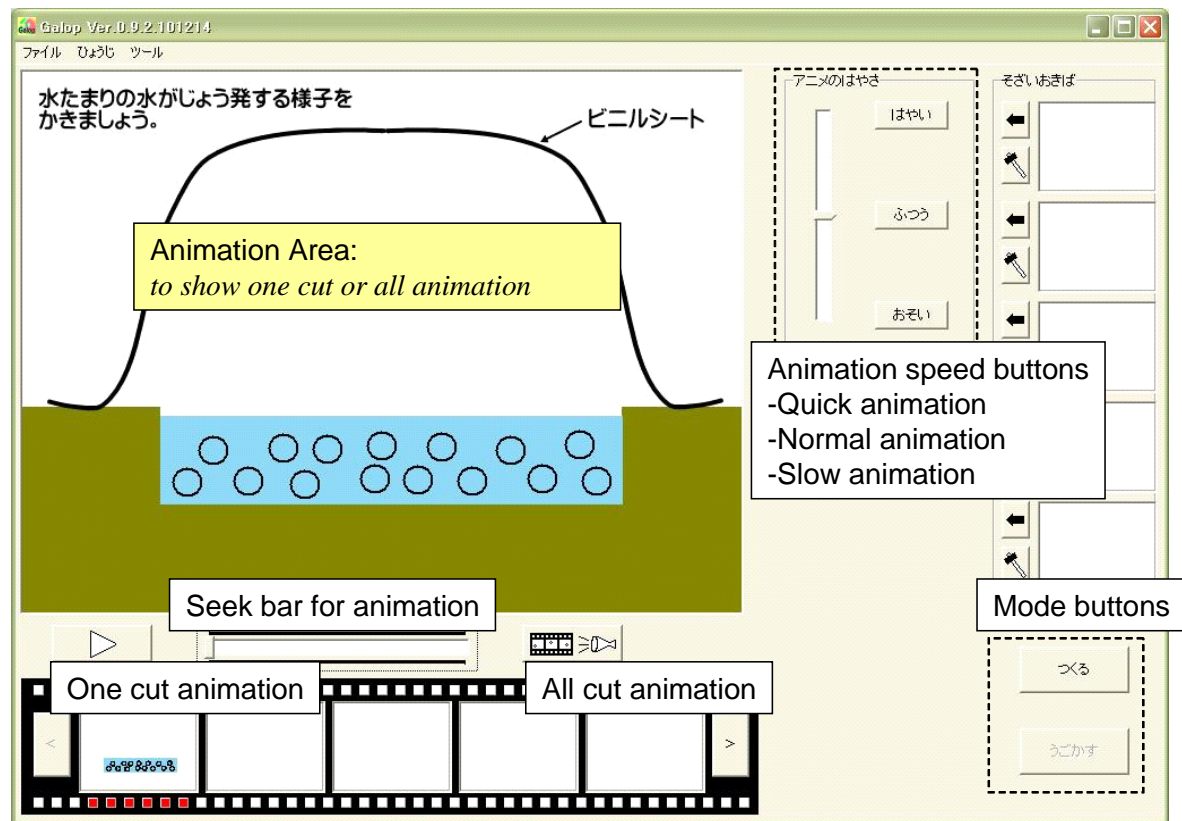


Fig. 6. Animation mode of Galop

4. Educational Practice

In order to confirm whether students can express dynamic phenomenon by Galop or not, we did educational practice in a science education (4th grade of elementary school, 60 students). Target domain was “water evaporation” and student expresses the phenomenon. After this practice, we obtained the following comments from the teachers:

There were few students who could not understand the animation making method,

- They concentrated to express the phenomenon,
- The idea and thinking of each student can be confirmed by making and playing animation.
- Reconstruction of understanding can be found through animation making, and
- There were communications about scientific concept in the context of teaching Galop operations among students.

Finally, all students could express evaporation phenomenon. Through this practice, we confirmed that students could express dynamic phenomenon by Galop.

5. Conclusion

In this paper, we described the needs of an animation system for science education through the use of Polk in science classes. Then we described development of the animation making system called "Galop" for students to understand about phenomenon in the science education by expressing dynamic phenomenon. To express them, students can easily make

animations by using Galop. As for the future works, we use Galop at many science classes and improve our system.

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References

- [1] McCloskey, M. Caramazza, A. & Green, B. (1980). Curvilinear Motion in the Absence of Extensional Forces: Naïve Beliefs about the Motion of Objects, *Science*, 250(5), 1139-1141.
- [2] Clement, J. (1982). Students' Preconceptions in Introductory Mechanics, *American Journal of Physics*, 50(1), 66-71.
- [3] Oldham, V. Driver, R. & Holding, B. (1987). A Case Study of Teaching and Learning about Plant Nutrition, *Children's Learning in Science Project*, 66-85.
- [4] Brook, A. Driver, R. & Hind, D. (1989). The Development of Pupils' Understanding of Physical Characteristics of Air, Across the Age Range 5-16 years, *Children's Learning in Science Project*, 16-47.
- [5] Hayashi, T. Naruo, Y. & Nakayama, H. (2004). Polka: a Repeat-Playable-Drawing System for Drawings in Scientific Model Learning, *Proceedings of ED-MEDIA2004*, 84-87.
- [6] Fujisawa, S., Hayashi, T., Nakayama, H., & Tarumi, H. (2009). System Design of an Animation Making System for Drawing Dynamic Phenomenon, *Proceedings of the 17th International Conference on Computers in Education (ICCE 2009)*, 738-742.
- [7] Inagaki, S. Funaoi, H. & Yamaguchi, E. (2001). Development and Evaluation of Concept Mapping Software to Reconstruct Learning Processes, *The Journal of Science Education in Japan*, 25(5), 304-315. in Japanese
- [8] Kariyado, T. (2000). Supporting Children's Self-Awareness through the Digital Paint Tool "Noh-no-kagami, *Japan journal of educational technology*, 24(Suppl.), 203-206. in Japanese
- [9] Naruo, Y. & Nakayama, H. (2003). Primary School Children's Ideas of Electric Current Expressed in Explanation with Drawing by Tablet, *Research Report of Japan Society for Science Education*, 17(5), 59-62. in Japanese.