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Collaborative Inductive Problem Solving Using an ICT Tool in an Elementary Science Classroom

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Abstract: This paper describes the effect of a real-time tool, MetaMoji *ClassRoom*, on collaborative discussions around the varied results of science experiments in an elementary school. The principle of our science education is to find materials and scientific questions from everyday experiences and investigate these questions with experiments and observations. Sharing the results of varied group experiments, the class attempts inductive inference to arrive at a generalized conclusion. The effects of the collaboration tool on students' awareness of other groups' results were suggested from their notes. Significantly, more texts referring to others' results were found in the students' notes when the experimental results were shared using the tool. We then measured the time process of commenting on the results of the group experiments, visualized by the collaboration tool. Comments fulfilling students' discussions were indicated within 20 min. This efficiency of collaboration enables the classroom to take enough time to carry out inductive inference to arrive at a generalized conclusion based on the variety of experimental observations.

Keywords: collaborative learning, real-time collaboration tool, ICT-based science education, inductive inference

1. Introduction

The goal of our science education is to encourage students to participate in scientific practices and to develop scientific explanations for real daily life phenomena. Scientific explanations are developed through arguments. Likewise, science learning is shaped by experience and collaborative discussions (2016, Lehrer and Schauble). Also, for most individuals, learning takes place most effectively conducted via social interactions (1978, Vygotsky, 2003, Redish).

The educational principle of this study is to engage students in a scientific exploration of the daily life phenomena and facilitate their collaboration to make inductive inferences. To enhance the efficiency of such collaborative activities within a limited time of the classroom and to let every student participate in the discussions, we introduce a collaboration software. In this study, we first examine whether the students are better aware of other groups' experiment results collected on the tablet. Then we analyze the time process of their exchange of comments using the tool.

2. Method

The tablet devices used were Apple iPad Air 16GB and Mini2 16GB. Every student was provided with a tablet. The application software introduced was *ClassRoom* (MetaMoji Corporation). The *ClassRoom* assembled and shared handwritten notes, characters, and images uploaded to the cloud server, allowing simultaneous accesses from more than ten classrooms of 40 students. To collect the experiment results on the tool, the teacher prepared a *note* that consisted of the teacher's layer and the student's layer which was divided into nine cell experiment groups. The student's layer consisted of the data layer and the discussion layer to overlay comment texts on the objects in the data layer.

First, comparison of the whiteboard and the tablet as the collaboration space was carried out in two classes, in which fifth-grade students had activities on the "solubility of objects" from October to December 2015. The control classroom, which was equipped with a whiteboard, was attended by 17 males and 20 females. The experiment class was attended by 18 males and 19 females with Apple iPad. The ages of students are from 10 to 11. Second, the time process of commenting using the tool was recorded at a lecture on the "plant growth" in July 2016. Fifth-grade students (17 males and 17 females, at the ages from 10 to 11) attended the class.

3. Results and Discussions

3.1 Comparison between Whiteboard and Tablet

Figure 1. Sharing and discussing the experiment results. **Left**: experiment results were gathered in the collaborative tool, *ClassRoom*, on the tablet. Students look at the result by enlarging or reducing the images. **Right**: experiment results were put on a whiteboard, and the students look at these results.

Figure 1 compares the manner of inspecting experiment results gathered in the tool (left) to the whiteboard (right). The students of the classroom with the tool can make notes on what they find in their tablets on their desks, while the students of the whiteboard class were seen to gather and talk with each other in front of the whiteboard.

Table 1 shows the number of students who referred to the other groups' results (collaborative reference) in the worksheets. By the 5% level χ^2 test, the number of collaborative reference were significantly higher when using the *ClassRoom* app compared to the whiteboard (χ^2 (1, N = 71) = 4.058, $p < .05$). This indicates that the interface of the app is beneficial for noticing the other groups' results and comparing them with their results while enhancing the attitude of students toward discussing the similarities or differences among the results.

Table 1: Occurrence of collaborative reference in the students' notes, "today's title."

	Collaborative Reference [person]	Other Description [person]	Sum
ClassRoom App	23	13	36
Whiteboard	14	21	35
Sum	37	34	71

3.2 Commenting on Experimental Results

Figure 2 left shows a snapshot of the display. The students pasted comment labels on the results. Label colors indicated their views as approval of the results, disapproval, and a question to the group. Figure 2 right shows the time development of the number of labels pasted for experiments on plant seed germination and the condition of growth. In both experiments, approximately linear developments were found within the first 10 min. For plant germination, the rate of labels increased; η for the first 9 min was $\eta = 2.9$ min^{-1} and for the conditions of growth, the value of η for the first 16 min was $\eta = 5.0$ min^{-1}, indicating the students concentrated on inspecting and commenting on other groups' results intensely.

On average, the students pasted 2.8±1.7 times for plant germination and 3.7±1.7 times for plant growth. The activity seemed saturated within approximately 20 min.

These results indicate a notable efficiency both in paying attention to the many sample data obtained under shared questions and in the arguments on the real data.

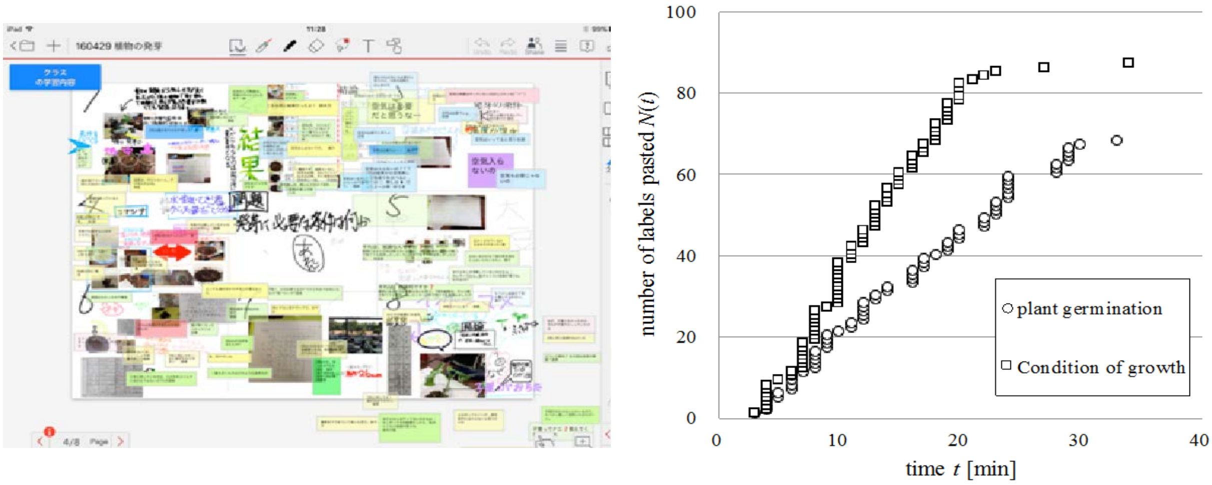

Figure 2. **Left:** display of the experimental results and comment in *ClassRoom* display. Right: time development of the number of labels pasted in *ClassRoom* display.

4. Conclusions

We introduced the collaboration tool *MetaMoji ClassRoom* to the science class of an elementary school, to facilitate students' exchange and discussion of the results of experiments with various conditions.

The proportion of discussion that included the other group's results was found to be significantly higher for students using the collaboration tool, indicating that the use of the tool was beneficial both for bringing the variety of results together and for accessing each other's results.

The arguments were recorded by superimposing comment labels onto the images of the results. The students were found to enter comments repeatedly within approximately 20 min. This is efficient as an activity of the discussion of experiments, which is followed by the discussion to arrive at a generalized conclusion within the class time.

Thus, this study suggests that use of collaboration tool is effective for gathering information and facilitating students' discussion of a variety of experiment results before they take time to engage in inductive inference in the classroom.

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