

Enhancement of the Digital Fortune Line System for Accelerating Mutual Examination of Learners' Conceptual Ecologies

Etsuji Yamaguchi^a, Hideo Funaoi^b, Shigenori Inagaki^c,
Akiko Deguchi^d, Naohisa Misawa^e, Shinichi Kamiyama^f

^a*Faculty of Education and Culture, University of Miyazaki, JAPAN*

^b*Graduate School of Engineering, Hiroshima University, JAPAN*

^c*Graduate School of Human Development and Environment, Kobe University, JAPAN*

^d*Faculty of Education, Utsunomiya University, JAPAN*

^e*Elementary School of Obayashi Seishin Joshi Gakuin, JAPAN*

^f*Sumiyoshi Elementary School Attached to Faculty of Human Development, Kobe University, JAPAN*

etsuji@cc.miyazaki-u.ac.jp

Abstract: We developed the Digital Fortune Line System for supporting the externalization and sharing of learners' multiple ideas and their commitment to those ideas. We used the Conceptual Ecology Model [4] as a theoretical base, and mobile and wireless network technology as a technological base. Based on the results of the evaluation research of the previous version of the system, this research newly added the name display function and the line display function in order to enhance the system, especially the counting function. These functions were added in order to support mutual examination of learners' conceptual ecologies by enabling learners to instantly identify targets of questions and counterarguments, and by seamlessly coordinating the summary screen and the fortune line display screen. After implementing the new version system in the same science curriculum used in the evaluation research of the previous version system and analyzing the subjective evaluation of the system by 37 fourth-graders (10 or 11 years old), it has been revealed that the new version system will support the mutual examination more effectively than the previous version system.

Keywords: mobile & wireless network, conceptual change, fortune line

1. Theoretical Background

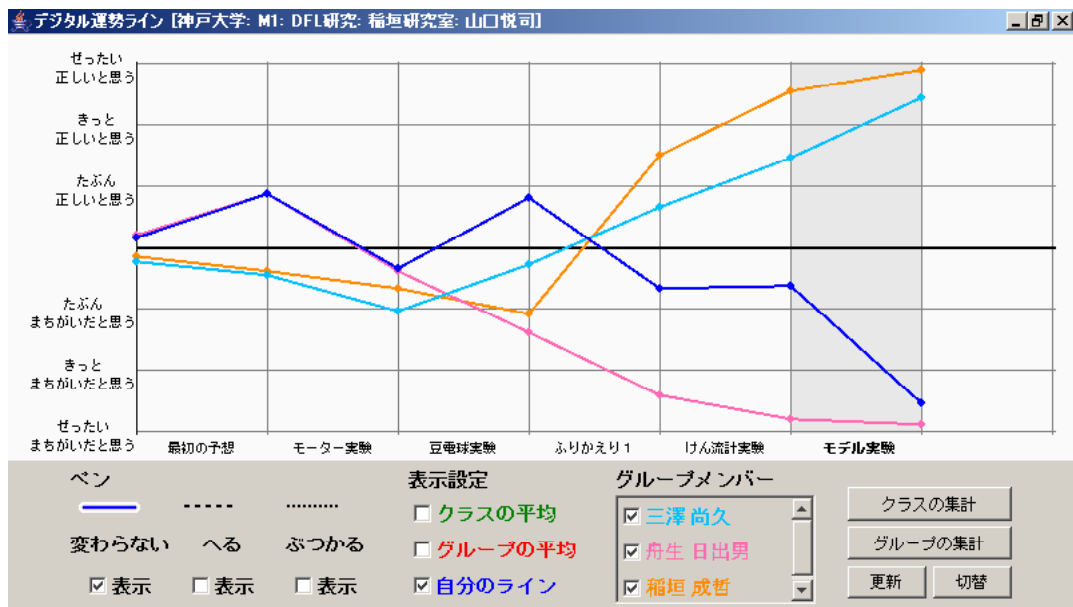
1.1 Conceptual Change and Conceptual Ecology

Posner et al.'s model of conceptual ecology [4] is one of the most widely accepted models by researchers and teachers who aim to promote conceptual change in science education [1]. According to the theory of Posner et al.'s conceptual ecology model, learner's concepts can be expressed or described as their ideas and commitment (emotional attachment) to those ideas. Therefore, in teaching and curricula that aim to promote conceptual change based on the conceptual ecology model, it is essential to allow each learner's multiple ideas regarding a specific learning topic and his/her commitment to those ideas to be externalized and shared.

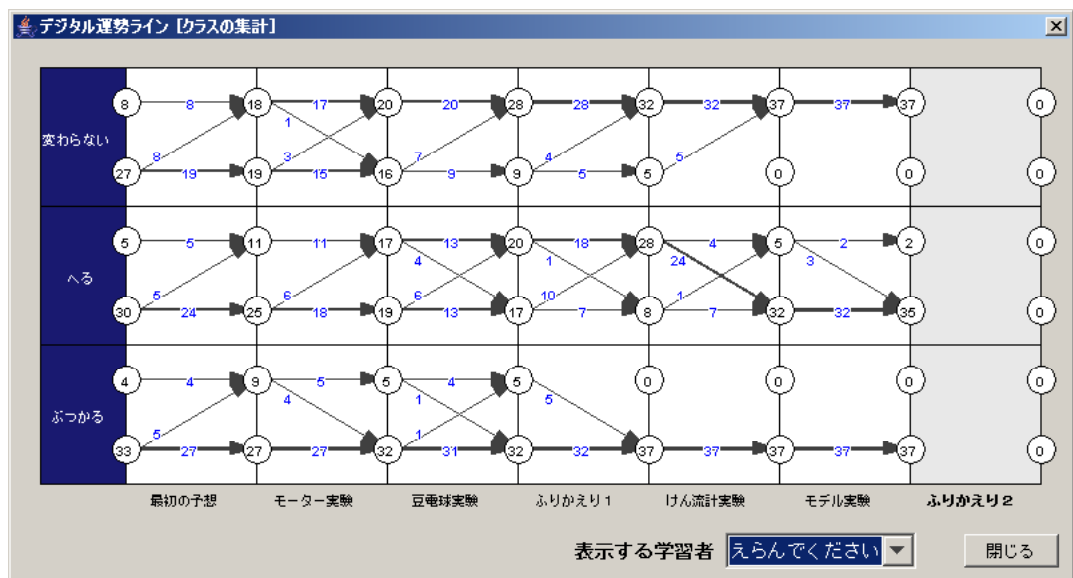
1.2 Digital Fortune Line System

We developed the Digital Fortune Line System for supporting the externalization visualization and sharing of learners' multiple ideas and their commitment to those ideas [2]. The System has three functions through mobile and wireless network technology. (1) Basic function: The user can input different types of lines (e.g., solid line, dashed line or dotted line) by selecting the appropriate pen (Figure 1a). (2) Layer display function: The user can display the fortune lines of other group members on his/her screen by selecting the check box of the group member(s) whose fortune line(s) he/she wishes to view (Figure 1a). (3) Counting function: The user can count and display the "number of people who wrote a line in the upper area" and the "number of people who wrote a line in the lower area" in their class or group, through the summary screen (Figure 1b).

1.3 Problems of the previous system and Requirements for enhancement



1a: Input / Display Screen



1b: Summary Screen

Figure1: Digital Fortune Line System

From the results of the evaluation research of the system conducted through an elementary school science curriculum, it was clarified that the counting function did not adequately support the mutual examination of students' conceptual ecologies in discussions involving the entire classroom [3][5].

What are the requirements for enhancement the system, specially counting function? Based on the case analysis of class discussions using the counting function, adding the following two new functions is considered as necessary.

The first is the name display function in the summary screen. In the case of class discussion, the number of students considering the idea to be right and the number of students considering it wrong were compared, but the discussion seldom progressed to further steps such as "I want to hear more of the opinion of students who think this idea is wrong" or "I want to make a counterargument to students who think this idea is right." If a function that instantly displays the names of the students with a click on the numbers of the summary screen were available, students would be able to instantly identify targets of questions or counterarguments.

The second is the line display function on the summary screen. In the case of class discussions, a student's fortune line was displayed when that student was presenting his/her idea. However, because the student's fortune line could not be instantly displayed, interruptions in discussions were often observed. If the function to display the fortune line of a student by clicking on the student's name displayed by the name display function were available, interruptions in class discussions would be eliminated, and more time can be spent on mutual examination of conceptual ecologies of students.

2. Purpose of Study

The purposes of this research are the following two: (1) to add the name display function and the line display function in order to enhance the Digital Fortune Line System, especially the counting function, and (2) to implement the new version system in the same science curriculum used in the evaluation research of the old version of the system and analyze the results of the subjective evaluation of the system by the students in order to evaluate whether or not the new version system will be more powerful in accelerating mutual examination of students' conceptual ecologies within class discussions.

3. Enhancement of Digital Fortune Line System

Figure 2 is the interface of the name display function and the line display function. The user can click on the number displayed on the summary screen to display the names of all users comprising that number. They can click on any one of the names, and the fortune line for that name will be displayed on another window.

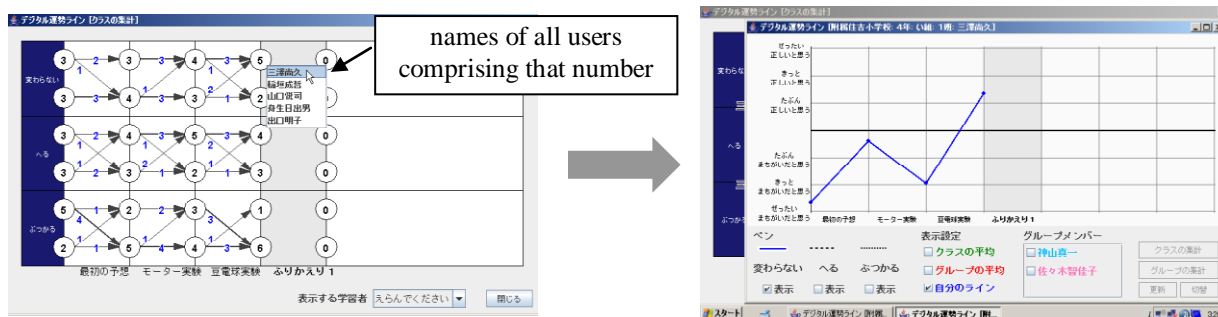


Figure2: Name display function and line display function

4. Evaluation of The New Version

4.1 Method

Subjects: The subjects were 37 fourth-graders (10 or 11 years; 18 boys and 19 girls) in Japanese elementary school. They used the Digital Fortune Line System for the first time. There was no student who had participated in the evaluation research on the previous version.

Elementary Science Curriculum Using The Digital Fortune Line System: The curriculum was developed for use in the “Electricity” unit in the standard Japanese fourth-grade science curriculum. Various conditions of the curriculum implementation were almost the same as the evaluation research on the previous version. The class was divided into groups consisting of three or four members each. Each group was provided with one “SmartCaddie”. Each student performed the creation and presentation of a fortune line individually (Figure 3).

Survey: The survey was conducted in a questionnaire comprising 38 items. 28 items of 38 items were the same as the evaluation research on the previous version system. 10 items of 38 items were newly added for the new version system. These items were answered using a four-stage Likert scale.

Procedure: The questionnaire was administered simultaneously to all students in class after the lesson. The questionnaire took approximately 15 minutes.

4.2 Results

Table 1 shows the evaluation results of the both old and new versions of the Digital Fortune Line System regarding the two question items concerning the effectiveness of the counting function in supporting learning. Results of old version system were quoted from [5]. For the purpose of comparison of versions, the Mann-Whitney U test was conducted. The results showed that the new version scored significantly higher than the old version on every question item ($U=474, p<.05; U=480.5, p<.05$). Therefore, the test revealed that many of the students positively evaluated the new version system as more powerful in supporting mutual examination of students’ conceptual ecologies in class discussions than the old version system.

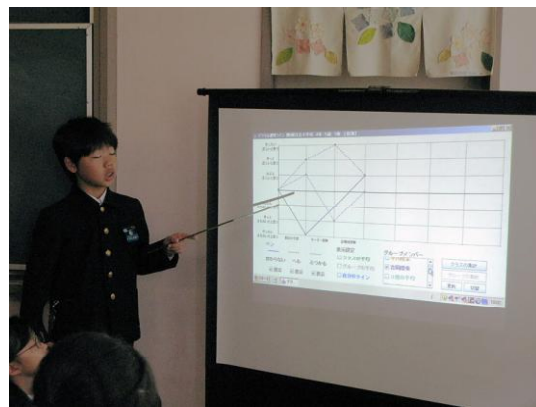
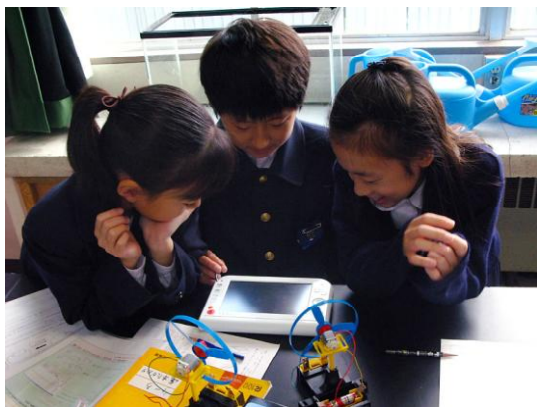


Figure3: Students used the Digital Fortune Line System

Table 1: Comparison of the old version system with new version system

	TS	STS	DQTS	DTS
(29) Viewing the summary screen made me want to ask a question or to give my opinion.				
Old version system	13	10	8	6
New version system	22	9	5	1
(30) Viewing the summary screen livened up discussions with my friends.				
Old version system	15	7	11	4
New version system	21	13	3	0

$N = 37$ (Old version, New Version). TS: Think so, STS: Somewhat think so, DQTS: Don't quite think so, DTS: Don't think so. Results of old version system were quoted from [5].

The results about new 10 items shows that many students acknowledged that the use of the name display function and the line display function supported the understanding of conceptual ecologies of others in context of the ecological distribution of the entire class, as well as the mutual examination of students' conceptual ecologies in class discussions.

5. Future Tasks

Currently, we are analyzing other assessment data, collected from students who learned this prototype curriculum. Such data include videorecording of the lesson in which students using the system and some tests conducted to evaluate students' conceptual change. We are planning to examine the outcome of analyses of the results presented here in a comprehensive manner and discuss whether the system can be a useful educational technology for promoting conceptual change.

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