Multiple Line System for Visualizing and Sharing Students' Commitment on the Tablet PC

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Abstract: We enhanced and evaluated a system for visualizing and sharing the students' commitment to multiple ideas that runs on the iPad/iPad mini. This system has the following two functions: a) the function for the student to represent his/her commitment to multiple ideas, and b) the function to count the distribution of the students' commitment. We conducted a science lesson using this system targeting Japanese sixth grade elementary school students. Students were asked to input their commitment to the ideas each time they conducted an experiment. Subsequent to drawing the line the second time, the whole class discussed the commitment situations using the counting function. After the lesson, we investigated students' impression about the usability of the system and class discussion using the counting function. The results showed that this system was quite easy to use and effective in supporting learning that focuses on tracking the process of commitment change.

1 INTRODUCTION

It has been pointed out that it is important to visualize and share students' concept as an external representation in science education that support conceptual change (e.g., Duit and Treagust, 2012). This is because conceptual change is promoted when students share their own concepts and examine the differences among them.

Among the representation methods recommended by the theoretical study of conceptual change, a model that researchers and teachers consider promising is the conceptual ecology model by Posner et al. (1982). It regards conceptual change as a process of natural selection of multiple ideas (encompassing theory, knowledge, etc.) that exist within the intellectual environment. Each student is considered to have multiple ideas, rather than a single idea, ranging from the ones higher in the ecological hierarchy, which have successfully adapted to the intellectual environment, to those lower in the ecological hierarchy and facing extinction. A curriculum aiming to promote conceptual change in students by using the conceptual ecology model is required to visualize and share students' commitment to multiple ideas

related to the lesson. In the past, a method that shows the commitment as a line by using pen and paper has been used (White and Gunstone, 1992).

In recent years, there have been attempts to display the commitment line on a system instead of using pen and paper. For example, Funaoi et al. (2006) and Nakashin et al. (2012) have developed systems to visualize and share the commitment to multiple ideas. These systems run on an iPod Touch. However, since the iPod Touch has an inherently small screen, its operation is not necessarily easy. In terms of visualization of commitment, difficulties have been observed in tracking the process of students' commitment change and its reason.

Therefore, in order to overcome the challenges described above, we developed a system in this study that visualizes and shares the commitment running on an iPad/iPad mini, which have become increasingly popular in recent years. The purpose of this study is to introduce this system to a science lesson at an elementary school in Japan, and conduct a preliminary assessment of its usability and effectiveness in supporting learning that focuses on tracking the process of commitment change.

2 OUTLINE OF THE SYSTEM

2.1 Development Environment

The development environment for the client side (iPad/iPad mini) is Xcode 5. The development environment for the server side is Windows 7 (Professional), Tomcat 6.0, and MySQL 5.5. The system can run on other operating systems if equivalent services are available.

2.2 Operation of the System

This System has the following two functions: a) the function for the student to represent his/her commitment to multiple ideas (hereinafter referred to as "the representing function"), and b) the function to count the distribution of the students' commitment (hereinafter referred to as "the counting function"). The representing function is performed on the iPad/iPad mini operated by each student. The counting function is performed on the PC operated by the teacher. The teacher's PC screen is displayed using a projector or large LCD TV in the classroom.

First, we will explain the representing function. Figure 1 shows the system configuration. Although it only shows one iPad/iPad mini, multiple devices can be connected to the server to share the inputted commitment. Once the System is launched and the school, grade, class, group, lesson unit, name of the student, and password are entered, the commitment input screen is displayed as shown in Figure 2. The vertical axis represents the level of commitment and the horizontal axis represents the progress of the lesson in time. First, tapping the button on the bottom left corner of the screen shown in Figure 2 will allow you to begin inputting your commitment. You can specify the level of commitment by dragging the square cursor up and down, and then confirm the level by tapping the cursor. Once confirmed, a line connecting the level of commitment inputted earlier to the level of commitment inputted most recently is displayed. When inputting commitments for different ideas,
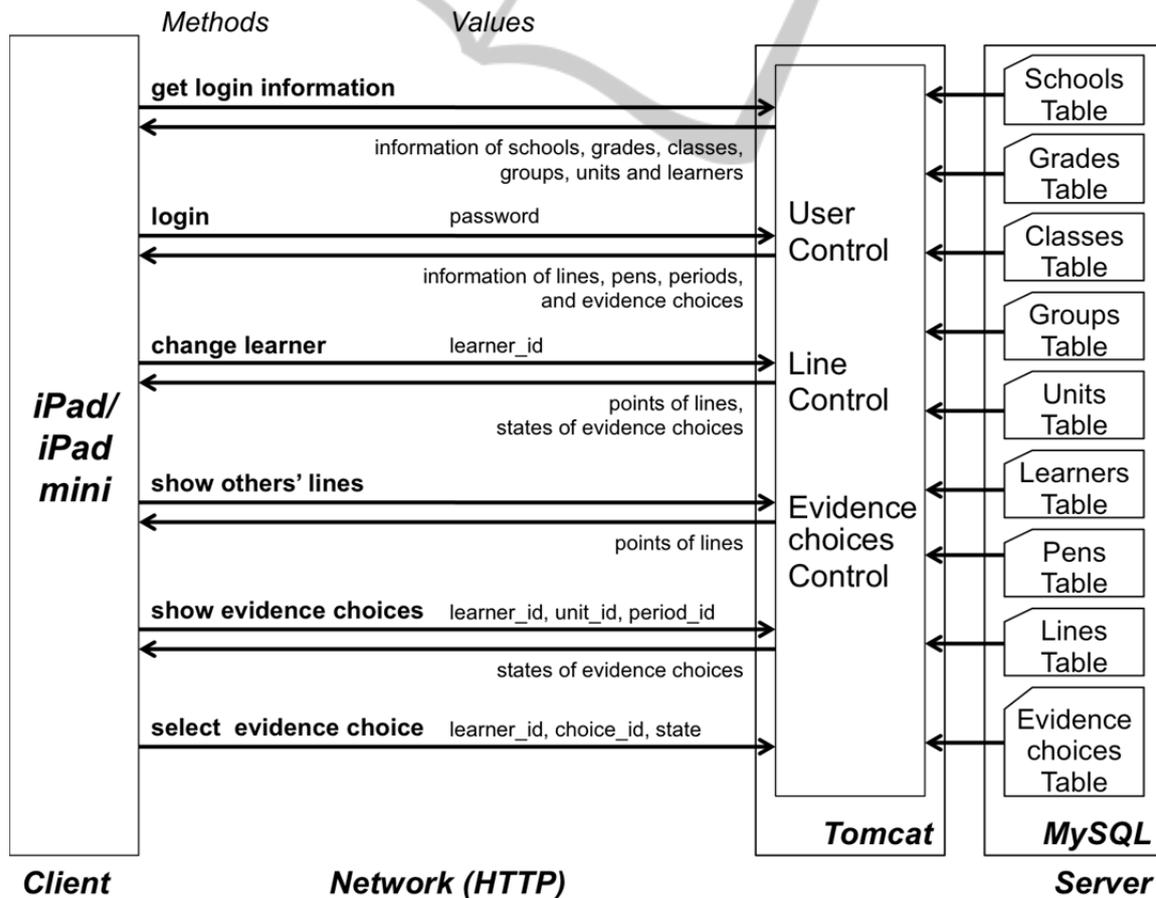
Figure 1: The system configuration.

tapping the button on the bottom right of the screen shown in Figure 2 will display the idea selection screen for inputting the commitment. The data on inputted commitment is sent to the server via the network and then stored in a MySQL Database through the control unit in Tomcat.

Next, we will explain the counting function. The counting function features the ability to list combinations of commitment changes to multiple ideas. When the request is sent from a teacher's PC, the commitment information inputted by students is read from the MySQL Database and then the combination of commitment changes to multiple ideas is displayed. This counting function focuses on the commitment inputted by students for the second time among all instances of input. It is possible to count the number of students who changed their commitment in the second round of input from "correct" to "incorrect", or vice versa and display a matrix of the commitment change combinations for two ideas. Figure 3 is the counting function screen. Here we can see that there were three students who changed their commitment to Idea A from "incorrect" to "correct", and their commitment to Idea B from "correct" to "incorrect". The use of this function

allows us to track the process of the change in commitment to two ideas.

3 EVALUATION OF THE SYSTEM

3.1 Evaluation Method

3.1.1 Purpose

The purpose of the evaluation was to clarify the following two points: 1) whether the system is easy for the participants to use, and 2) whether class discussion using the counting function promotes the sharing of commitment among students.

3.1.2 Participants

The participants included 40 sixth-grade students (11-12 years old) at an elementary school in Japan. They had never used this System prior to this study. One iPad mini was assigned to every two students for inputting their commitment. The counting function was performed on a laptop operated by the teacher. The teacher, who was certified to teach
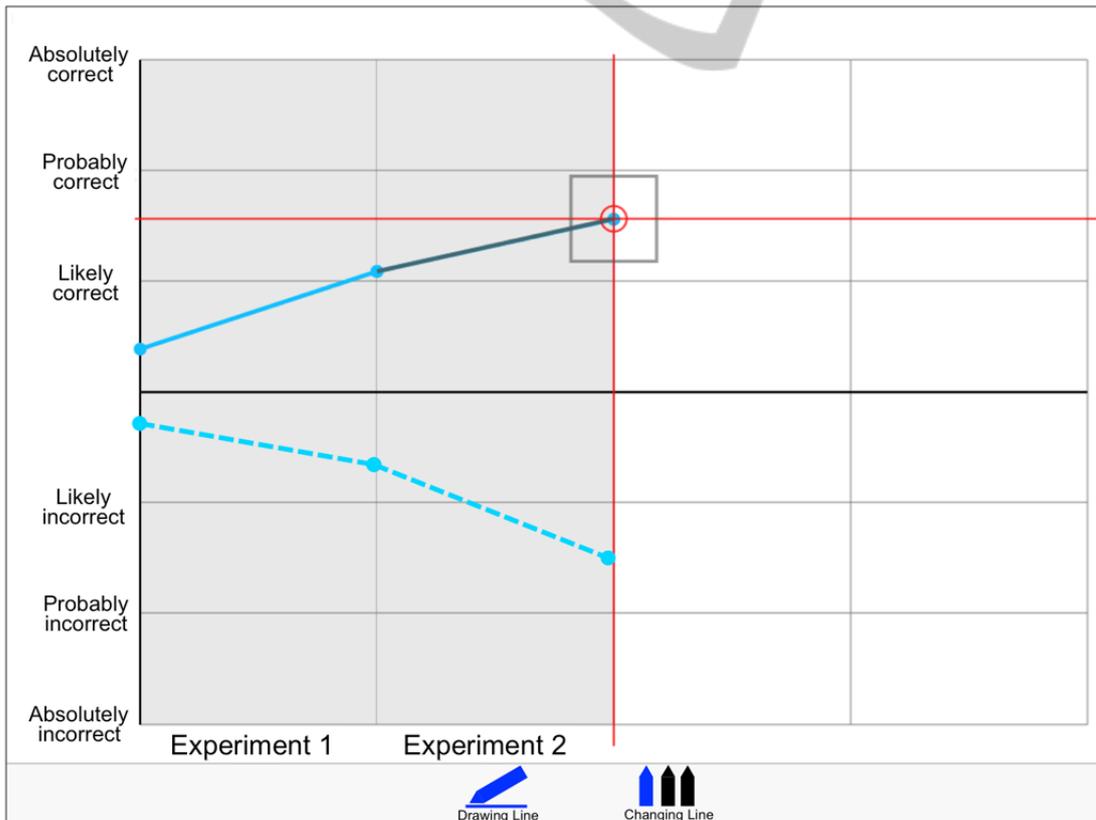
Figure 2: The commitment input screen.

science, had 15 years of teaching experience. The PC screen was mirrored on a LCD.
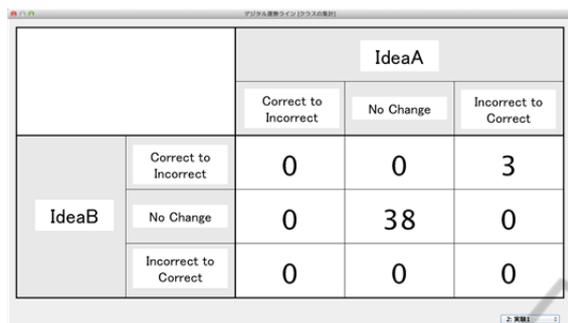
		IdeaA		
		Correct to Incorrect	No Change	Incorrect to Correct
IdeaB	Correct to Incorrect	0	0	3
	No Change	0	38	0
	Incorrect to Correct	0	0	0

Figure 3: The counting function screen.

3.1.3 Tasks

The evaluation tasks were to investigate the students' impressions about the usability of the system and class discussion using the counting function.

3.1.4 Procedure

First, a total of nine science curriculum units (one unit is 45 minutes) were conducted. The lesson subject was static electricity. The aim of the lesson was to change a scientifically invalid idea ("There are two types of non-conductive objects: those that become electrically charged, and those that do not," referred to by the teacher and the students as the "Two Types Theory") to a scientifically valid one ("All non-conductive objects become electrically charged," which was referred to as the "All Theory") through hands-on experiments and discussions. Students were asked to input their commitment to these two ideas each time they conducted an experiment. In the first experiment, the students brought a charged drinking straw, charged paper bag, and charged plastic ruler into close proximity to a charged drinking straw. In the second experiment, they brought several charged objects into close proximity with a thick enamel wire. The charged objects were the following: a drinking straw, plastic ruler, candle, glass rod, and rubber hose. In the third experiment, they brought a charged drinking straw into close proximity with several non-charged objects: a piece of wire, plastic ruler, glass rod, spring onion, and pretzel snack. The line was drawn for a total of four times during the science curricular units. Subsequent to drawing the line the second time, the counting function screen was displayed on a large LCD every time the line was drawn, and the whole class discussed the commitment situations. After the lesson, an interview survey was conducted

among four randomly selected students regarding the evaluation tasks. The tasks were performed using the individual interview method, which took about 10 minutes per person.

3.2 Results

First, we will describe the results of the interview survey on the usability of the system. Table 1 shows comments regarding the usability of the system extracted from the interview survey. S1 stated that it was possible to quickly draw a line when inputting a commitment because the drag and drop response time was good. This is a comment related to the response speed of the System. S2 commented on the screen size and the ease of the steps used to draw a line. S2 said it was easy to draw lines because there were no unnecessary steps before inputting the commitment. Regarding the iPad mini's screen size, S2 said it was appropriate and pointed out that it could become difficult to read if the screen size were smaller than that of iPad mini. Both S3 and S4 mentioned the fact that they were able to get used to inputting the commitment. They reported it was because they were able to immediately grasp the information necessary for operation.

Next, we will describe the interview results about the counting function. Table 2 shows comments regarding the counting function. First of all, S1 mentioned a case in which he asked why a few students changed the commitment that they supported. S1 said he understood from the counting function that there were three students who changed their commitment to All Theory from "incorrect" to "correct;" consequently, he became interested in those three students since only a few in the class made this commitment change, and felt like asking why they changed their commitment. Next, S2 stated that from the counting function he understood that the majority of students did not change their commitment to All Theory and Two Types Theory, which made him want to ask each student why their commitment didn't change. This is a comment on a case in which a student asked why the commitment supported by the majority didn't change. Furthermore, S3 mentioned a case in which he asked others who made a commitment change different from his to express their reason. S3 did not change his commitment because he thought All Theory was incorrect at the first opportunity he had to input his commitment as well the second. However, he said that it made him want to ask why there were others who changed their commitment to "correct" in the second round even though they had thought All

Theory was incorrect, as S3 did, when the first commitment was inputted. Finally, S4 said that he became eager to hear what others thought when he noticed there were others who changed the commitment as he did, because he thought there

Table 1: Comments regarding the usability of the system, extracted from the interview survey.

S1:	It was nice because when I used the system to draw a line, it responded well to normal touch and I was able to draw the line in a minute or so.
S2:	It was easy to use because it is compact, there are no unnecessary steps to draw a line, and the procedure to draw a line was easy. The size of the screen was also just right. I think it would probably be difficult to read the screen if it were smaller than that.
S3:	Using this system was really easy, and I immediately found out what was written where. I think I also got used to writing on it right away.
S4:	I got used to the steps to draw a line within minutes because it was easy to draw the line. The screen was okay to read.

S1:Subject1 / S2:Subject2 / S3:Subject3 / S4:Subject4

Table 2: Comments regarding the counting function, extracted from the interview survey.

S1:	Even though there were only three who changed from "incorrect" to "correct", I think it was rather useful because it got me interested in how people changed their thinking based on this experiment.
S2:	Because I immediately saw on the screen that there were many people who did not change, I thought it would be a good idea to ask each person what he/she thought.
S3:	I kept thinking that All theory was incorrect. So when I saw there were three people who changed from "incorrect" to "correct", it made me wonder why they changed their mind, why they thought All theory was correct, and so on. It just got me thinking.
S4:	It made me want to ask people who changed their mind from All theory is "incorrect" to "correct" their opinions. I wanted to ask because I changed my mind the same way, you know, and I thought it might influence my thinking if I heard the reason why they thought that way.

S1:Subject1 / S2:Subject2 / S3:Subject3 / S4:Subject4

might be other reasons even though the commitment change was the same. This is a comment about a case in which a student asked why others made the same commitment change.

4 CONCLUSIONS AND FUTURE WORK

The purpose of this study was to introduce the system for visualizing and sharing the students' commitment running on the iPad/iPad mini to a science lesson at an elementary school in Japan, and to conduct a preliminary assessment of its usability and effectiveness in supporting the learning.

First, we will consider the interview results regarding the usability. The results of the survey showed the operational effectiveness from the following four perspectives: 1) the responsiveness of the screen when inputting commitment is fast, 2) the steps to input commitment are easy, 3) the information necessary for inputting commitment is easy to understand, and 4) visually confirming information such as words on the screen is easy because the screen is large. Based on these results, we found that the System was easy for the participants to use.

Next, we will consider the interview results regarding the counting function. The four cases obtained in the interview survey can be roughly divided into two categories. The first are cases in which a student finds other individuals whom he wants to ask questions based on the population distribution trends displayed by the counting function, as in the cases of S1 and S2. There, the students were interested in the population distribution that stood out, such as commitment changes supported by a few students or by the majority. Therefore, the examination of the difference in ideas necessary for students' conceptual change may be promoted. The second are cases in which, like S3 and S4, a student compares their own commitment change to other individuals' commitment changes and finds whom to ask questions. There, students were interested in others who made the same commitment change or a different commitment change. This case may be more desirable because it may promote the examination of the differences in ideas, which is necessary for conceptual change among students, even more so than in the case of S1 and S2, by allowing students to compare commitment changes among others with their own commitment change for examination.

The future tasks include the following two. The first is to conduct a quantitative analysis of the usability of the system and the effectiveness of the counting function in supporting the learning. The second is to qualitatively analyze comments made by students and the teacher during the class discussion that used the counting function.

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