

# Improving the Usability of Manga-on-a-Tablet for Collaborative Learning

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Abstract: The purpose of this study was to develop a tablet PC version of a system that promotes the learning of knowledge and skills related to science teaching, and to investigate its effectiveness. The characteristic feature of this system is that it supports collaborative learning through discussions based on case method materials by a manga (comic strip). The system makes students read scenes of a children's experiment displayed on the screen in the form of a manga. Touch operations on parts of interest enable students to point pins. Pins are color-coded in four colors. Students use the share functions to share awareness with each other and hold discussions to solve problems. We conducted an experimental evaluation with university students who intended to become elementary school teachers. The evaluation showed that the proposed system is effective in promoting discussion through the sharing of awareness.

## 1 INTRODUCTION

Fostering the talents and abilities of teachers and enhancing their expertise are currently recognized as key issues in teacher training. The pedagogical content knowledge (PCK) approach to teacher talent and ability promoted by Shulman (1987) is widely known (e.g., Gess-Newsome and Lederman, 1999; Mishra and Koehler, 2006). PCK is undoubtedly knowledge that is linked directly to the practical ability and expertise of teachers. With many of Japan's experienced teachers now approaching retirement, the country faces the issue of how to pass on the knowledge and skills of these teachers to their successors. The field of science education focuses on acquired knowledge and skills related to experimental equipment and teaching materials, but a sufficient number of teacher education materials have not been developed to enable young teachers and teaching-track university students to acquire such knowledge and skills.

Daikoku et al. (2013) responded to this problem

by developing a tablet PC-based pilot version of case method materials that uses a manga designed to enable teaching-track university students to gain the knowledge and skills required for guiding students through experiments in science classes.

Manga is a familiar medium to young people; it enables stories to be read and understood relatively quickly, and can provide the information that students need to get in a focused manner. Tablet PCs can draw on these characteristics of manga to provide texts in a simple format. Further, since tablet PCs can communicate with each other to enable information sharing, they can provide a collaborative learning environment (e.g., Kim et al., 2009; Reid and Ostashevski, 2011). Using these texts, students read a manga depicting scenes of a science experiment conducted in the elementary school. They can append markers to each scene, share and discuss them with other students, and collaboratively learn the knowledge and skills required of elementary school teachers. However, the pilot version of this system only provided some functions

for indicating and sharing awareness. For example, there were no functions for identifying who entered a marker or for seeing the entire manga in the list format.

To overcome these shortcomings, in this study, we developed a system that added the name display capability to the function for sharing awareness, and included a manga and pin list function. We also conducted an experimental evaluation of the system with teaching-track university students. The study's aim was to verify the system's operation and its effectiveness in promoting discussion among the users through the sharing of awareness.

## 2 SYSTEM OVERVIEW

### 2.1 Development Environment

The tablet PC development environment was Adobe Flash Professional CS6, enabling the system to be published as applications for iOS and Android. The server development environment consisted of Windows 7 (Professional) , Apache 2.2, PHP 5.3,

and MySQL 5.5. The system can be operated on other operating systems if an equivalent service can be used.

### 2.2 System Configuration

Figure 1 shows the system configuration. The diagram only shows one tablet PC, but naturally, multiple tablet PCs are connected to the server, enabling the sharing of the entered pins and other data. After logging into the system from a client tablet PC, the user can view any manga page and use functions such as the pin entry function on any manga frame location at which the user wants to flag a problem. The information for these operations is sent over the network to the server and stored in a MySQL database through a control unit on PHP. When the "show others' pins" message is sent from a tablet PC, the information for all the pins entered in the manga being viewed is read from the MySQL database and returned to the tablet PC. The pins are then displayed on the tablet PC. In this way, students can share pins indicating awareness.

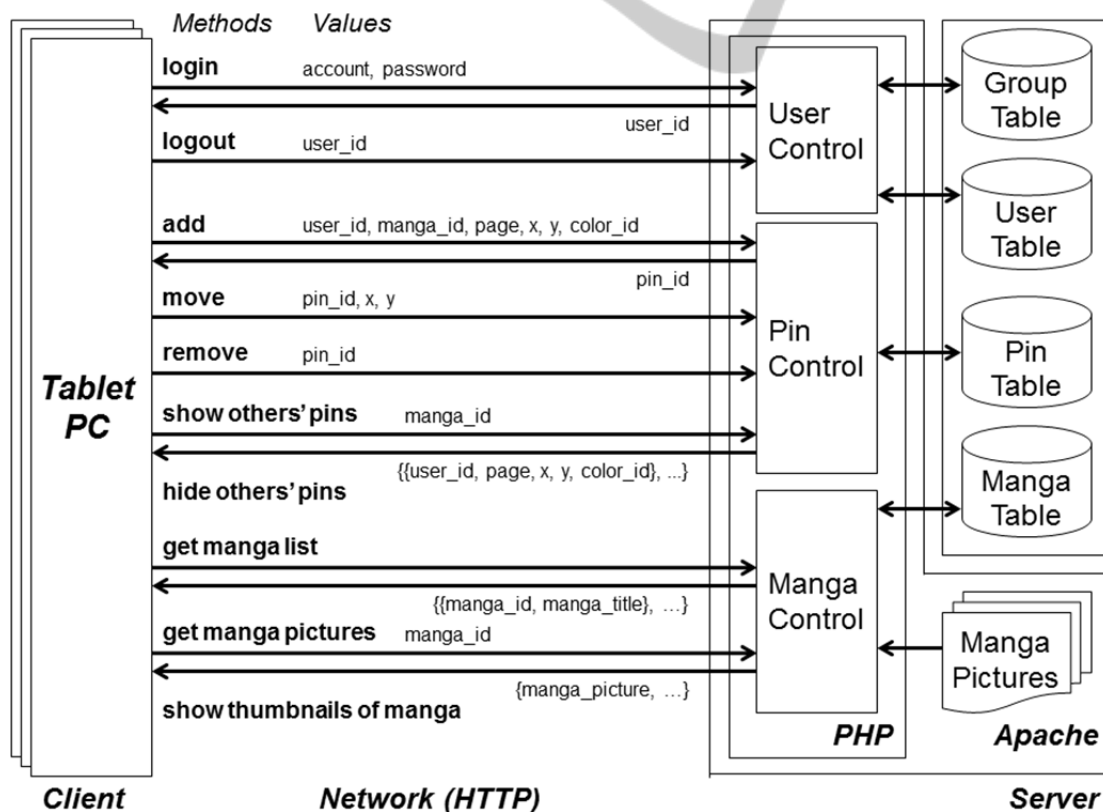


Figure 1: System Configuration.

## 2.3 Functions

Figure 2 shows the picture of the manga after logging in. In the diagram, awareness of individuals has been entered using the pin entry function.

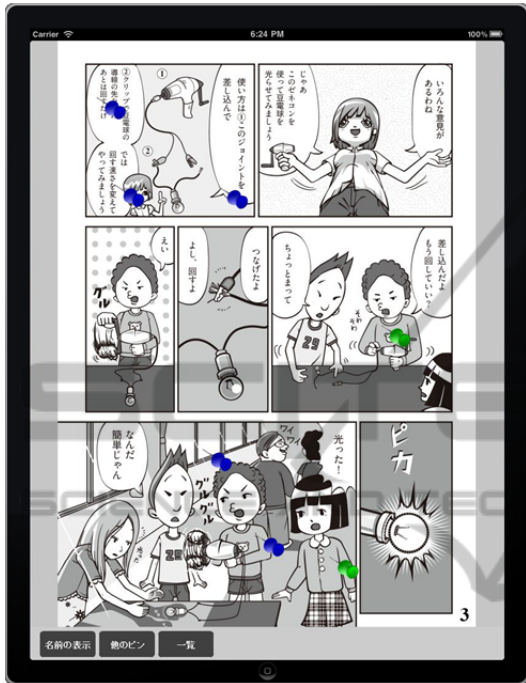


Figure 2: The picture of the manga after pin entry.

### 2.3.1 Manga Page Operation Functions

As with e-books for standard tablet terminals, swiping the manga to the right moves forward a page, while swiping it to the left moves back a page.

### 2.3.2 Pin Entry Function

Figure 3 shows the pin entry function. To enter a pin, the user touches the desired location (any location) in a manga for less than 1 s. The panel appears, containing pins of four colors (blue, green, yellow, and red). The user touches the pin of the desired color to enter it. Pins can be entered in a manga in this way to add annotations. Four colors of pins have been provided to enable students to color-code different categories of pin comments. Providing a meaning to each pin color clarified what each student focused on at each pin location. Pins in a manga can be moved by dragging them. Touching a pin for less than 1 s displays the panel. The user can then touch a pin of another color to switch the selected pin to that color. Touching the trash can delete the selected pin.

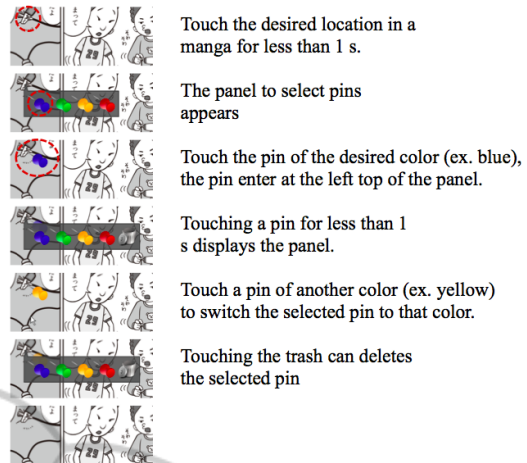


Figure 3: Pin entry function.

### 2.3.3 Manga Page Operation Functions

As with e-books for standard tablet terminals, swiping the manga to the right moves forward a page, while swiping it to the left moves back a page.

### 2.3.4 Functions for Sharing Awareness

As shown in Figure 4, touching the “Other pins” button at the bottom of the picture of the system makes the display of pins added by other students on the same page translucent, enabling the sharing of awareness. As shown in Figure 5, touching the “Display names” button displays the name of the student who entered each pin at the right of the pin. The names of other students are translucent like pin.

These operations enable the sharing of pin comments among students. Paying attention to pin input locations and color movement could be expected to promote discussion activities.

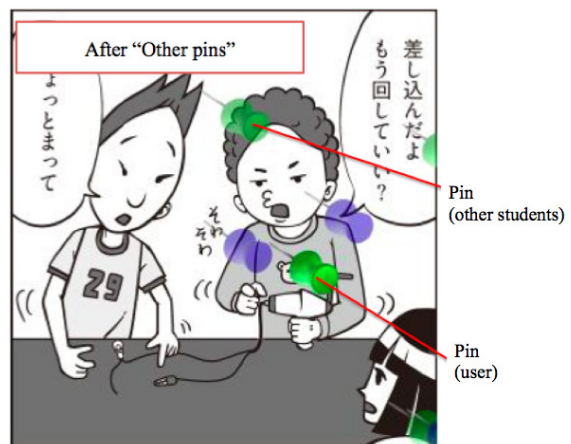


Figure 4: One scene of the manga after pin awareness sharing operation.

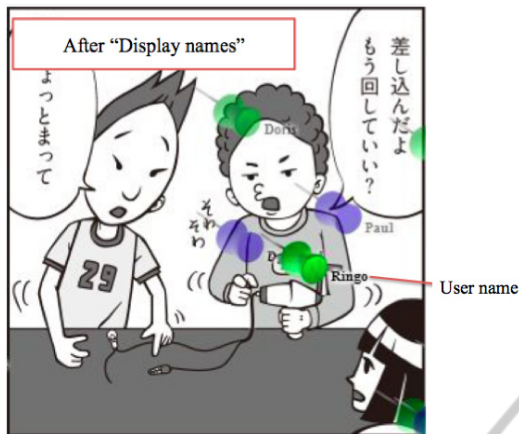


Figure 5: One scene of the manga after the display of names operation.

### 2.3.5 Manga and Pin List Function

As shown in Figure 6, touching the “List” button at the bottom of the picture of the system displays all the pages of the manga as thumbnails along with the entered pins. This function shows at a glance where comments have been entered throughout the entire manga along with the number of comments entered. Touching a thumbnail displays the selected page in the normal size.

In this way, the system enables the adding and sharing of noteworthy locations in various categories by means of pins in four colors, using only touch and gesture operations. It makes ample use of the convenience of tablet PCs.



Figure 6: The picture of the system using manga and pin list function.

## 3 EVALUATION EXPERIMENT

### 3.1 Evaluation Design

**Purpose:** To investigate the system’s operation and the effectiveness of discussions based on the sharing of awareness.

**Participants:** 32 university students planning to become elementary school teachers (13 men and 19 women). Participants were divided at random into groups of 4, for a total of 8 groups.

**Procedure:** Each group of participants took part in case method materials trial on tablet PCs. The procedure used was as follows: The participants first read the 8-page manga individually. Then, they entered pins for issues that they considered to be problematic in the story conveyed by the manga (for example, insufficient teacher guidance, broken equipment due to children’s misbehaviour, or a classroom environment unsuitable for the experiment). Finally, each group shared the pins entered by its members and held a discussion on the basis of these pins. After the case method materials trial, the participants evaluated the system by using the questionnaire method.

**Evaluation items:** There were two categories of evaluation items—items about the system’s usage and operation, and items about the sharing of awareness about manga frames. There were 13 items about the system’s usage and operation. They covered areas such as manga visibility, page operation, and commenting operations. Some examples of these items are as follows: “Picture of manga after pin awareness sharing operation was easy to view” and “Manga viewing operations were easy.” There were 9 questions about awareness sharing. They covered the discussion held on the basis of the shared awareness; e.g., “Sharing enabled us to discover differences in awareness about manga frames” and “When sharing, it was easy to distinguish my own pins from other people’s.” There were 22 items in all. For each item, the respondents selected a number between 1 and 5, with 5 representing “Strongly agree” and 1 representing “Strongly disagree.”

Survey period: October 3 to 21 2013

### 3.2 Results

Table 1 presents a tally of the responses received for the usage and operation items and a compilation of the results. The responses received for each item were classified into positive responses and neutral/negative responses. In particular, the

Table 1: Questionnaire survey results of the usage and operation.

Items	1	2
1. Picture of manga after pin awareness sharing operation was easy to view **	31	1
2. I carefully considered problems in the children’s experiment while viewing the sharing system **	29	3
3. Operations for viewing the manga were easy **	26	6
4. It was easy to find the desired manga pages and frames **	27	5
5. It was easy to color-code problem importance levels by pin color *	19	13
6. The pin entry operation was easy <sup>n.s.</sup>	14	18
7. The operation for discarding entered pins was easy *	18	14
8. The operation for changing the color (importance level) of the entered pins was easy *	19	13
9. Pin awareness sharing operations were easy **	28	4
10. Picture of manga after pin awareness sharing operation were easy to view **	26	6
11. When using pin awareness sharing operation, important scene search operations were easy **	28	4
12. It was easy to distinguish other people’s pins from my own **	21	11
13. It was easy to count the number of entered pins **	28	4

N=32 \*\**p*<.01, \**p*<.05, <sup>n.s.</sup>not significant 1: Positive answer, 2: Neutral and Negative answer

participants responding with a 5 or 4 were classified as positive respondents; participants responding with a 3, 2, or 1 were classified as negative respondents; and the number of each type of respondents was tallied. We determined the statistical significance of the deviation between the number of positive respondents and that of the neutral/negative respondents by using a 1 × 2 exact test.

The results showed no statistically significant difference between the number of positive respondents and the number of neutral/negative respondents for one item (Item 6: Pin awareness sharing operations were easy). The number of positive responses trended higher for three items (Item 5: It was easy to color-code problem importance levels by pin color, Item 7: The operation for discarding entered pins was easy, and Item 8: The operation for changing the color (importance level) of entered pins was easy), with the difference between the number of positive respondents and the number of neutral/negative respondents being statistically significant at the 5% significance level. For each of the other 11 items, the number of positive responses trended higher, with the difference between the number of positive respondents and the number of neutral/negative respondents being statistically significant at the 1% significance level.

Table 2 presents a tally of the responses received for the items about sharing of awareness about manga frames and a compilation of the results. We analysed the results using the same procedure used for the usage and operation items, determining the statistical significance of the deviation between the

number of positive respondents and that of neutral/negative by using a 1 × 2 exact test.

As a result, for each of the 9 items (such as Item 14: Sharing awareness enabled us to discover differences in awareness about manga frames and Item 20: Sharing awareness enabled a lively discussion in the group), the number of positive responses trended higher, with the difference between the number of positive respondents and the number of neutral/negative respondents being statistically significant at the 1% significance level.

#### 4 CONCLUSIONS

The experimental evaluation results demonstrated the following two points: (1) The system’s interface has effective operation. (2) The system effectively promotes discussion based on shared awareness about manga frames.

However, there is a need to improve the convenience of the interface for the pin entry, movement, and erasing functions. Specific changes could include improving the response and mounting a continuous operation method enabling flick-based pin color selection and changes.

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Table 2: Questionnaire survey results of the sharing pin awareness about manga frames.

Items	1	2
14. Sharing awareness enabled us to discover differences in awareness about manga frames **	31	1
15. When sharing, it was easy to distinguish my own pins from other people's **	23	9
16. Sharing awareness enabled us to discover differences in reasons for awareness about frames **	29	3
17. It was easy to find manga frames in which many pins of the same color had been entered **	31	1
18. It was easy to find locations where pins of different colors had been entered in the same frame **	29	3
19. It was easy to decide on which manga frames to discuss **	21	11
20. Sharing awareness enabled a lively discussion in the group **	28	4
21. Simultaneous sharing awareness and discussion enabled a good understanding of other people's opinions **	30	2
22. Simultaneous sharing awareness and discussion enabled explanations that were easy to understand **	29	3

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