

# Improvement of children's logical thinking by a digital pen system environment

**Noriyuki MATSUNAMI**  
Graduate school of System Design  
Tokyo Metropolitan University  
Hino, Tokyo, Japan

**Shinya MIURA**  
Nishi-Tokyo City Sakae elementary school  
Nishi-Tokyo, Japan

**Saki TOMODA**  
Nishi-Tokyo City Sakae elementary school  
Nishi-Tokyo, Japan

**Masahiro NAGAI**  
University Education Center  
Tokyo Metropolitan University  
Hachioji, Tokyo, Japan

and

**Hitoshi KIYA**  
Graduate school of System Design  
Tokyo Metropolitan University  
Hino, Tokyo, Japan

## ABSTRACT

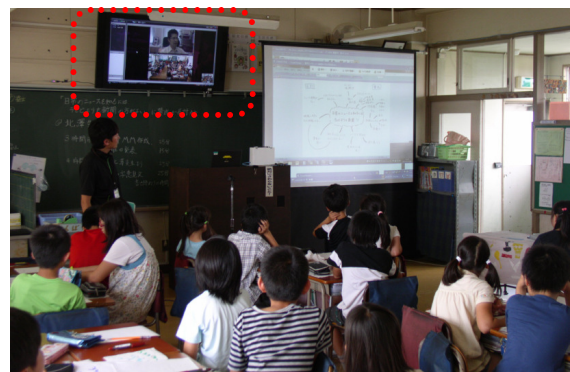
Recently, the results of a PISA survey pointed out a decline in logical thinking in Japanese children. In response, we engaged teachers in educational practice research and encouraged children to participate in collaborative learning using a digital pen and "mind-maps"\* method. We intended to improve children's logical thinking and their ability to support their ideas with valid statements. Expert teachers provided instruction from a remote location using a video conferencing system. Through this educational practice research, we found an increase in the number of valid statements written by the children.

**Keywords:** Digital Pen, Mind Map, Collaborative Learning, Idea Sentences and Expert Teachers

## 1. INTRODUCTION

Based on survey results from PISA 2009, we concluded that children's reading skills have improved. They are good at finding and extracting necessary information; however, they are not good at understanding and interpreting relationships and connecting knowledge to their experience [1]. This finding indicates that current elementary school children have problems in logical thinking. Referring to Matsunami et al. [2], we developed lessons in collaborative learning to be taught by an expert teacher with experience in logical thinking. Lessons

utilized a digital pen and a mind map and were conducted by video conferencing (Figure 1). Mind maps were shared using the remote desktop system because it is usually difficult to see mind maps from a remote location (Figure 2).



**Figure 1:** The children receive instruction from an expert teacher (shown within the dotted line) from a remote location.

## 2. OBJECTIVES

In the lessons, the children used a digital pen to draw a mind map as part of collaborative learning. They were assisted with logical thinking by an expert teacher who provided instruction

from a remote location. This study investigated the improvement in children's logical thinking abilities in this learning environment.



**Figure 2:** A child shares and explains a mind map with the expert teacher.

### 3. METHOD

#### 3.1 The research subjects and duration

The research took place from June 1 to July 13, 2011. The subjects comprised 94 fifth graders in three classes from a Tokyo public elementary school. Fifteen lessons were taught. The children wrote "idea sentences" of approximately 400 characters before and after the lessons. Themes were quoted from "Training by idea sentences of 200 characters using the Fujiwara style" by Kazuhiro Fujiwara [3], although to some extent we revised this approach (Table 1).

Each child drew a mind map before writing the idea sentences on the theme. Based on conclusions from our research conducted last year, we extended the expert's teaching time by 15 minutes.

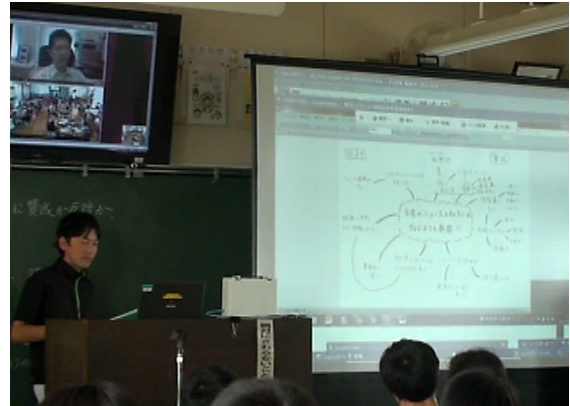
Theme 1: "Do you agree or not that we will go back to the past using a time machine?"
Theme 2: "Do you agree or not that we will get money by helping?"
Theme 3: "Do you agree or not that newspapers are better than television for providing news?"
Theme 4: "Do you agree or not that priority seats are not necessary in trains and buses?"

Table 1: Themes of lessons (Problems of lessons)

We believed that the expert's teaching time was too short in our prior research, because we could not find significant differences between "pre-" and "post-idea sentences" when we focused on the participation of the expert teachers [2]. Next, the expert teacher encouraged interaction (Figure 3) and ensured time for the children's questions (Figures 4 and 5). Finally, we evaluated the influence of the expert teacher's instruction on the children's idea sentences.

#### 3.2 Methods of evaluation

Logical thinking can be explained as the ability to write effective reasons for one's assertions [4]. We evaluated pre- and post-idea sentences with respect to the number of valid points and change in the children's viewpoint after completing 15 lessons.



**Figure 3:** An expert teacher shows a mind map to the children.



**Figure 4:** The expert teacher asks the children questions.



**Figure 5:** A child asks the expert teacher a question.

### 4. RESULTS AND DISCUSSION

#### 4.1 Differences in the number of valid reasons with and without expert teachers' participation

Our evaluation of the children's idea sentences found that the number of valid reasons, appreciated by teachers, increased after lessons compared with before lessons. In their idea sentences, many valid reasons were influenced by expert teachers, while there were valid reasons that were the children's own ideas. Figures 6–9 show the comparison of the number of valid reasons after standardization between pre- and post-idea sentences.

We further examined the results with respect to the presence of expert teachers because the number of valid points increased

even in the classes in which the expert teacher did not participate.

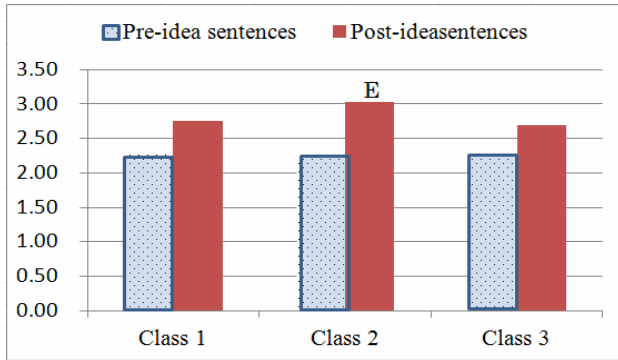


Figure 6: The number of valid points on theme 1

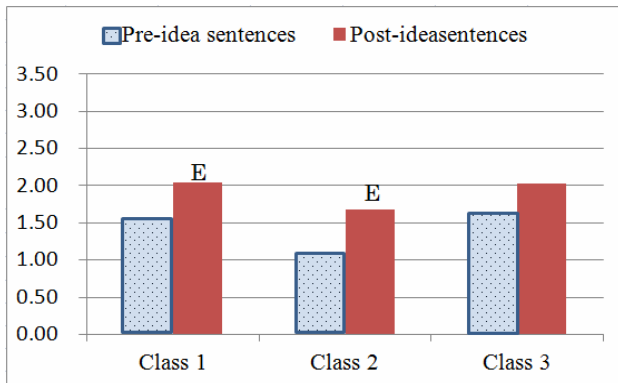


Figure 7: The number of valid points on theme 2

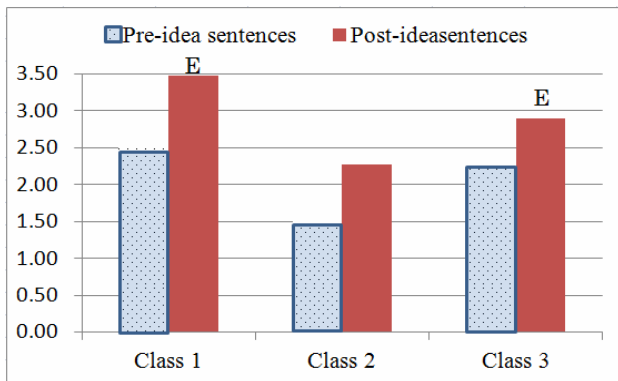


Figure 8: The number of valid points on theme 3

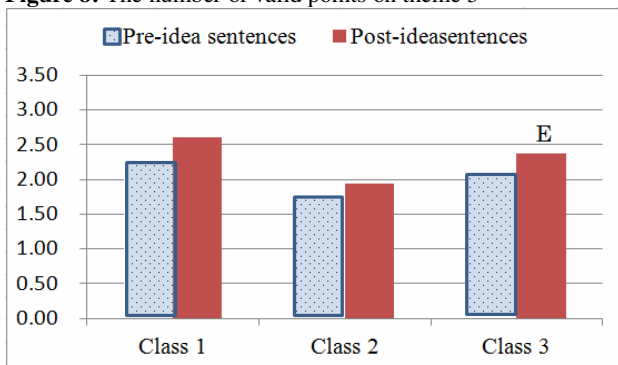


Figure 9: The number of valid points on theme 4

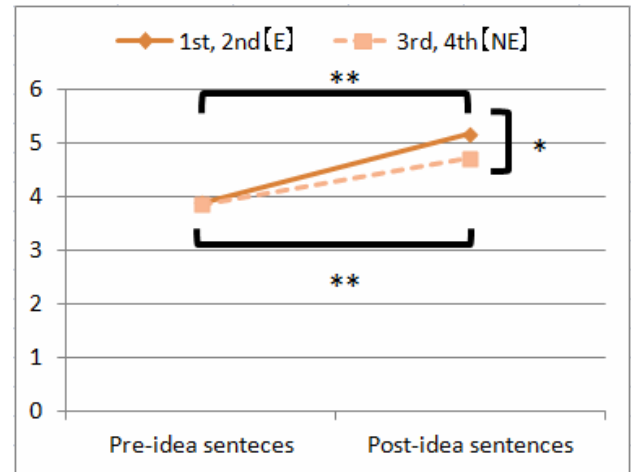


Figure 10: The number of valid points with and without the expert teacher's participation.

(\* $p < .05$ ; \*\* $p < .01$ , in Figures 10, 12, and 13)

("E" indicates that an expert teacher participated, and NE" indicates that an expert teacher did not participate)

Consequently, our evaluation showed that participation by the expert teacher significantly influenced students' post-idea sentences by comparing the number of valid points with and without their participation (Figure 10).

#### 4.2 Differences in the number of new valid points in the post-idea sentences

We counted the expression of valid reasons that were not written in the pre-idea sentences but appeared in the post-idea sentences (Figure 11). The number of new valid points was relatively bigger when these were added in the lessons in which the expert teachers participated.

We then analyzed the effect of expert teachers' participation and found that the average number of valid points was significantly higher when the expert teacher participated (Figure 12). Furthermore, we conducted a qualitative analysis on the children's idea sentences because there was no clear difference regardless of participating of the expert teachers in theme 3 (Figure 11).

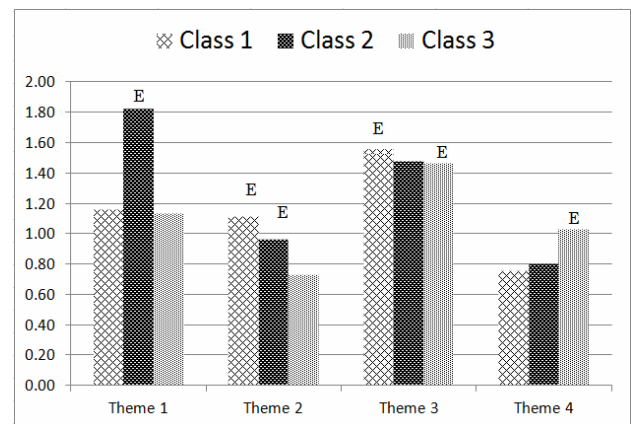
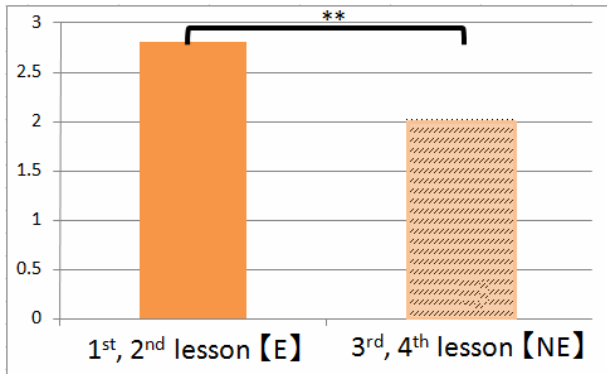


Figure 11: The number of valid points that were newly added by children in their post-idea sentences



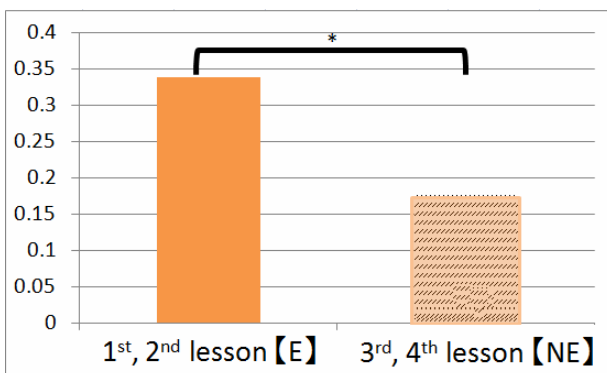
**Figure 12:** The number of valid points that were newly added by children with and without expert teachers participating

Theme 3 is "Do you agree or not that newspapers are better than television for providing news?" In checking the mind maps on this theme made by each group in all classes, we found the common keywords "Earthquake Early Warnings" only in class 2, in which the expert teacher did not participate. We believe that the stress and fearful memory of "the Great East Japan Earthquake" that occurred before the lesson affected the children's behavior and influenced their use of the keyword. Therefore, it seems that children added new, valid reasons that included these key words, although the experts did not participate.

#### 4.3 Difference in change of viewpoint in children's post-idea sentences

We evaluated change in children's viewpoints regarding whether or not they agreed with the statement of the theme. The children wrote their idea sentences after determining their viewpoint on the theme. We analyzed the number of changes in viewpoint between before and after the lessons. We found significant differences in the number of changes in viewpoint between classes in which the expert teachers participated and those in which they did not (Figure 13).

According to 4.1-4.3, it is clear that children learned to write the idea sentences using valid reasons by the instruction of the expert teachers.



**Figure 13:** The number of changes in children's viewpoint with and without expert teachers participating

## 5. CONCLUSION

In this educational practice research, we found that an expert teacher's instruction influenced the number of valid points, the

number of new valid ideas, and the number of changes in viewpoint in children's idea sentences.

Our results indicate that using a digital pen system, a mind map, and instruction by expert teachers conducting lessons from a remote location is effective in helping children write idea sentences using the concrete reasons. In other words, we consider that a learning environment using the digital pen system is relatively effective in leading to logical thinking. We were unable to clearly identify the kind of scaffolding that is effective in reaching this outcome, but we will pursue this line of research further.

\*Mind Map is a registered trademark by British Buzan Organisation Ltd.

## 6. REFERENCES

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