An Experimental Use of Learning Environment for Problem-Posing as Sentence-Integration in Arithmetical Word Problems

Tsukasa Hirashima[1], Takuro Yokoyama[2], Masahiko Okamoto[3], Akira Takeuchi[2],

[1] Information Engineering, Hiroshima University,
1-4-1, Kagamiyama, Higashi-Hiroshima, Hiroshima, Japan
tsukasa @isl.hiroshima-u.ac.jp
[2] Information Engineering, Kyushu Institute of Technology,
680-4, Kawazu, Iizuka, Fukuoka, Japan
{yokoyama, takeuchi}@ai.kyutech/.ac.jp
[3] Humanities and Social Sciences, Osaka Prefecture University,
1-1, Gakuen-cho, Nakaku, Sakai, Osaka, Japan
okamoto@hs.osakafu-u.ac.jp

Abstract. We have developed a computer-based environment for learning by problem-posing as sentence-integration. The system was evaluated through two months usage in classroom by the ninety-nine students belonging to three classes of an elementary school second grade. As the results, we found that (1) the second grade students of elementary school had posed problems continuously with the system, and (2) both students and teachers answered questionnaires that the problem-posing activity using this system was useful for learning. Moreover, we confirmed that (3) our system improved the problem solving ability of low performance students.
Keywords: Problem Posing, Problem Schema, Sentence Integration

1 Introduction

Learning by problem posing is well recognized as an important way to learn mathematics. For example, in the USA, documents promoting curricular and pedagogical innovation in mathematics education have called for an increased emphasis on problem posing activities in the mathematics classroom. Several investigations have also suggested that mathematical problem posing had a positive influence on the learners' problem-solving abilities or their attitude toward mathematics.

However, despite the importance of problem posing, it is not popular as a learning method in reality. This is due to a few factors. First, learners can make various kinds of problems, but some of the problems may be wrong. In addition, some of the learners might repeatedly make similar problems, or make problems that are too simple to be useful for learning. In such cases, adequate feedback for each problem is required. However, because learners can make a large range of problems, it is difficult to prepare adequate feedback for every problem that learners might make. In problem posing, assessment of each posed problem and assistance based on the assessment is necessary. Because the above task puts a heavy burden on teachers, it is very difficult

for teachers to use problem posing as a learning method. From this point of view, this "learning by problem-posing" is highly required to realize individual and intelligent interaction. Therefore, we have been investigating a computer-based learning environment for interactive problem-posing in arithmetical word problems [1]. We call the learning environment MOSAKUN.

In this paper, a use case of the environment for two months in elementary school second grade is reported. In this use, several computers installed the learning environment were set in several classrooms and allowed students to pose problems freely with the computers out of class time. Through this practical use, we evaluated the learning effect of the learning environment by long-term use and confirmed that whether it can be used by students by their own initiative.

2 Experimental Use of MOSAKUN in Classroom

The interface of problem-posing in MONSAKUN is shown in Figure 1. The area in left side, imaged blackboard, is "problem-composition area". At the top of the area, a calculation expression is presented. A learner is required to pose a problem that is able to solve by the calculation expression. Here, the expression is the solution-method. Although the expression itself is easy, the learner has to consider the combination of not only a number but also a subject, object and predicate in each sentence. The three blanks in the area are the ones to put sentence cards. Sentence cards are presented at right side of the interface. A learner can move the card by drag&drop method freely in the interface. When a learner pushes "diagnosis button" under the problem-composition area, the system diagnoses the combination of sentences. The results of the diagnosis and message to help the learner's problem-posing is presented by another window.

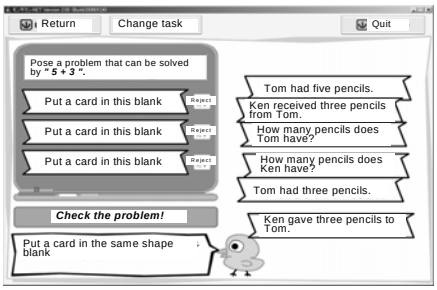

Figure 1. Problem-Posing Interface of MONSAKUN (Currently, it can deal with Japanese only. All words were translated into English for this paper).

2.1 Situation of the Experimental Use

Purposes of this experiment were (1) to examine the learning effect of long-term use of problem-posing with MONSAKUN, and (2) to confirm whether students use MONSAKUN of their own free will. For the first purpose, we used “extraneous problem test” which includes extraneous information that is not necessary to solve the word problem. For the second purpose, we examine the numbers of problems posed by individual students and the results of questionnaire.

Before this experimental use, two class times (ninety minutes in total) were taken as introductory use of MONSAKUN in a computer room of an elementary school

where each student were able to use one computer. Then, two computers installed MONSAKUN placed in each class (six computers were used in the school in total). So, about fifteen students were assigned to one computer. Teachers of the classes didn't instruct students to use the system but led to make rules to share the systems. The period of the experimental use was nine weeks including 46 school days. We carried out pre-test just after the introductory use, and post-test at the end of the period.

2.2 Results of System Use

The total number of problems posed by the six systems is 8,386. In a day, 30.4 problems were posed with a system. The average used days of each student is 8.5 days. In summary, three students were used a system a day and each of them posed ten problems. As the results of questionnaires, most of the students thought that the use of MONSAKUN made arithmetic enjoyable, and they hope to use it more. Teachers who had taken charge of the classes also agreed to these considerations. Because more than fifteen students shared one system, students could not always use the system when they liked to use. Besides, the available time of the systems was only out of class time. Considering these restrictions, the above results suggest that the second grade students were continuously able to pose problems with MONSAKUN by their own will, and accepted the use as learning and enjoyable activity.

In the analysis of the test of extraneous problems, based on the average score (= 8.32) of extraneous problem test, the students were divided into two groups: a high-score group and a low-score group. Then, the students were also divided into a high-posed group and a low-posed group based the median (= 77) of the number of posed problems by each student. As the results, the number of high-score and high-posed group is thirty-two, high-score and low-posed group is twenty, low-score and high-posed groups is twelve, and low-score and low-posed group is twenty-one. As the results, only low-score/high-posed students had significantly improved their scores.

3 Conclusion

Through two months use of MONSAKUN, we found that (1) the second grade students of elementary school had posed problems continuously with the system, and (2) both students and teachers answered questionnaires that the problem-posing activity using this system was useful for learning. Moreover, we confirmed that (3) our system improved the problem solving ability of low performance students.

References

1. Hirashima, T., Yokoyama, T., Okamoto, M., and Takeuchi A.: Learning by Problem-Posing as Sentence-Integration and Experimental Use, Proc. of AIED2007, pp.254-261(2007).