

Interactive Learning Environment Designed Based on A Task Model of Problem-Posing

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Abstract: Learning by problem-posing is a promising way to learn arithmetic and mathematics. In this paper, we report the design and development of an interactive learning environment for problem-posing as sentence-integration in arithmetic word problems. In this research, we have paid a special attention to “reverse thinking” problems. To find the characteristics of the reverse thinking problems, we built a task model of problem-posing and design the learning environment based on the model. This learning environment has been already developed and experimentally used in a class of fourth grade at an elementary school.

Keywords: Problem-posing, Task model of problem-posing, Reverse thinking problem

Introduction

Problem-posing is well known as a promising learning method to master the use of solution methods [1]. In the learning by problem-posing, because there are various problems that the learner can make correctly, the way to evaluate the posed problems is an important issue to realize this learning practically. We have been investigating computer-based learning environments that can assess and give feedback to each posed problem [2, 3] (we call this way of assessment as “agent-assessment”, in contrast with “teacher-assessment” or “peer-assessment”).

MONSAKUN is a learning environment of problem-posing which realized agent-assessment as simple sentence integration for arithmetical word problems that are solved by one operation of either addition or subtraction. In MONSAKUN, one simple sentence is composed of an object or event, an attribute and its value. A learner is provided with a set of simple sentences and is required to pose a problem by selecting and ordering them. This problem-posing process corresponds to “integration phase” of a model of problem-solving process of arithmetical word problems.

In previous version of MONSAKUN, however, only “forward thinking” problems are dealt with. In the forward thinking problem, a story represented in the problem has the same structure with the calculation to derive the answer. The previous version is enough to confirm the possibility of this learning environment through a short term use. However, it can not cover the arithmetical word problems solved by one addition or subtraction because learning of arithmetical word problems includes “reverse thinking” problems as advanced step. In the reverse thinking problem, since the structure of the story and calculation are different, a learner should comprehend the problem more deeply.

In this research, we modeled tasks of problem-posing including “reverse thinking” problems. An interactive learning environment that can deal with the reverse thinking problems have been designed and developed. Moreover, the learning environment is practically used by fourth grade students of an elementary school for the eight lesson times. In this paper, under Section 1, a task model of problem-posing as sentence-integration is introduced. An interactive learning environment has developed based on the model.

Because of page limitation, the implementation and the results of the practical use are omitted.

1. Task Model of Problem-Posing as Sentence-Integration

1.1 Task Model of Problem-posing at Reverse Thinking Problems

In a reverse thinking problem, the story operation and the calculation operation structures are different. Following is an example.

There were seven apples.

Several apples were eaten.

There are four apples now.

How many apples were eaten?

In this problem, the story operation structure is “ $7-?=4$ ”, and the calculation operation structure is “ $7-4=?$ ”. Because the two structures are different, a learner is required not only to understand the story but also has to derive the calculation operation structure from the story. This kind of problem is usually called “reverse thinking problem”. In this problem, operations in the story structure and in calculation structure are the same. Therefore, it is not so difficult to derive the calculation operation structure. Here, the operation is consistent in the story operation structure and the calculation operation structure, hence this kind of problem is called “forward operation reverse thinking problem” (called as “forward operation problem”). If the operation is a reverse one, it is called as “reverse operation problem”. Below is an example of the reverse operation problem.

There are several apples.

There are three oranges.

There are seven apples and oranges in total.

How many oranges are there?}

Since the story operation structure is “ $?+3=7$ ” and the calculation operation structure is “ $7-3$ ”, we can say the operation is different. This problem is required to derive the calculation operation structure from the story operation structure with the change of the operation. Therefore, a learner often feels difficult to solve this kind of problem.

1.2 Problem-Posing based on the Task Model

Based on the above considerations, we have proposed a task model of problem-posing as sentence-integration shown in Figure 1. The task model of problem-posing consists of following four tasks, (1) deciding calculation operation structure, (2) deciding story operation structure, (3) deciding story-structure, and (4) deciding problem sentences. A learner should complete these tasks to pose a problem correctly though the execution procedure of the tasks is not decided in the model.

In the first step of problem-posing in MONSAKUN, subtraction or addition is selected as a calculation operation. In the second step, a story operation structure is decided. For example, for subtraction, four story operation structures can be selected. Only one story operation structure is same from the calculation operation structure and two of them have different story operation, that is, addition. Because this is an abstract transformation, it is often very difficult for learners.

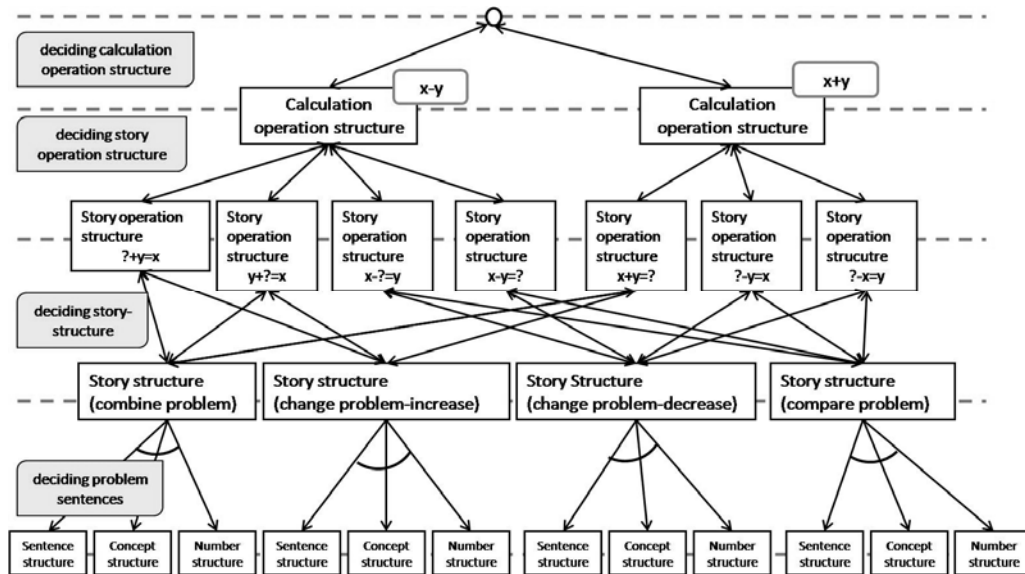


Figure 1. Task model of problem-posing as sentence integration

Arithmetical word problems solved by one addition or subtraction are usually categorized into the following four types: 1) increase-change problem, 2) decrease-change problem, 3) combine problem, and 4) compare problem. For example, decrease-change problem is composed of “existence sentence (there were seven apples)”, “decrease sentence (several apples were eaten)” and “existence sentence (there are four apples now)”. In the phase of deciding story structure, a learner should select one of them.

In deciding problem sentences, sentences are put into the story structure following the story operation structure. This task is divided into three more tasks: deciding sentence structure, deciding concept structure and deciding number structure. The deciding sentence structure means that to select and order sentences following the story structure. For example, if the story structure is the decrease-change, make a sentence structure composed of the existence sentence, the decrease sentence, and the existence sentence in turn.

2. Concluding Remarks

We have already developed MONSAKUN for the reverse thinking problems. We then conducted a practical use of MONSAKUN at formal arithmetic lesson times (8 lesson times) at an elementary school. These results suggested that MONSAKUN is a useful tool to improve student's ability of problem posing and it is accepted by learners and teachers as a useful learning tool.

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