Problem Representation and Categorization Training for Expert and Novice Problem Solving

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Abstract

Present study identified categorization pattern differences between experts and novices and examined whether categorization training has positive effects on problem solving. The results showed that experts classified problems based on deep structure related to problem solution, novices, however, classified problems based on surface features. The results also indicated that solution training was more effective to expert group whereas categorization training was more effective to novice group. We have discussed that different training methods should be applied according to expertise.

Introduction

Differences in problem solving between experts and novices are in large part caused by their different ways of problem representation (e.g. Chi, Feltovich, & Glaser, 1981). For example, experts tend to classify to problems based on deep structures related to abstract principles whereas novices tend to classify problems based on surface features (Chi et al., 1981). Furthermore, Boster and Johnson (1989) found that novices have difficulty in identifying deep structures of problems because they categorize problems based on surface features.

Then it can be hypothesized that if we explicitly provide novices with deep structures of problems, they can categorize the problems in the same way that experts do. We can test this hypothesis by examining whether intensive training of categorization is transferred to novel problems of the same domain. To address this question, we conducted two experiments. Experiment 1 was designed to identify categorization differences between groups varying with expertise. Experiment 2 was designed to examine whether categorization training enhances problem solving performance.

Experiment 1

The purpose of experiment 1 was to examine whether performance on problem categorization differentiate expert from novice and intermediate. We hypothesize that when we manipulated a level of similarity between surface content and deep structure, experts classify problems mainly depends on deep structure whereas novices concern with surface content

Methods

Participants. Sixteen undergraduate students of Yonsei University participated in this experiments.

Procedure. This experiment involved a pretest, a free categorization test, and a labeled categorization test. For pretest, five simultaneous equation problems were distributed to participants in order to divide them into expert, intermediate and novice groups based on the number of correct answers. After pretest, we provided participants with 18 problem cards and asked them to classify the cards freely into several groups. In the labeled categorization test, however, participants were given the same 18 cards that used in the previous test and they were asked to categorize the cards according to three kinds of simultaneous equations.

Material. The stimuli used in free and labeled categorization tests were problem statements of simultaneous equations that have deep structures and typical surface contents (Blessing & Ross, 1996; Ross, 1996). Besides the typical equation problem, two problem statements with the same deep structure but neutral or atypical surface contents were also produced. The dependent measure of incorrect responses was calculated by the number of wrong answers.

Results and Discussion

There were significant categorization score differences between groups varying with expertise, $F(2,13) = 6.343$, $p < .05$. Experts classified problems based on deep structures related to problem solution methods whereas novices classified problems based on surface features. However, in the labeled categorization condition, no significant mean accuracy differences between groups, $F(2,13) = .860$, $p > .05$, were found. These results suggest that novices' categorization pattern was not different from experts', that is,

novices were able to classify problems based on deep structures when deep structures of problems were presented.

Experiment 2

The purpose of Experiment 2 was to examine whether categorization training in which deep structures of problems are explicitly presented increases transfer performance. Specifically, we compared one condition with categorization training with the other condition without categorization training.

Methods

Participants. Seventeen undergraduate students of Yonsei University participated in this experiments.

Procedure and material. This experiment consisted of three stages, pretest stage, training stage, and transfer stage. The pretest was executed to divide participants into expert and novice groups. Then, each group of participants was divided into two training conditions; categorization or solution. In categorization training condition, participants were instructed to identify a correct equation to solve each problem out of three illustrated equations. In solution training condition, participants were instructed to solve and answer each problem without identifying required equations. All problems used in pretest and training stages were the same as those used in Experiment 1. Finally in the transfer stage, six new problem statements were provided to test participant ability to solve problems of simultaneous equations. Both accuracy and latency to solve equations were measured. Since there was no time limit to solve problems, almost all participants obtained 100% accuracy. Thus we analyzed the latency to examine ability to make solutions for each group of participants.

Results and Discussion

In pretest, there was a significant latency difference between expert and novice groups, $t(15) = 5.884$, $p < .001$, whereas there was no significant latency difference between solution training and categorization training conditions, $t(15) = 1.004$, $p > .05$, which suggests that both training conditions were comparable between both expertise groups.

At transfer, as shown in Figure 1, there was a significant latency difference between experts and novices, $F(1,13) = 6.539$, $p < .05$, while there was no significant latency difference between two training conditions, $F(1,13) = .277$, $p > .05$. However, there was a significant interaction between expertise and training condition, $F(1,13) = .5.575$, $p < .05$. These results suggest that solution training was more effective for experts whereas categorization training was more effective novices.

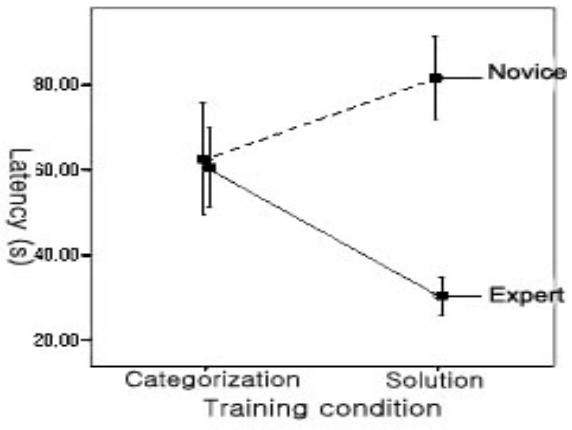

Figure 1. Mean latency for novices and experts as a function of training conditions.

General Discussion

The goal of this study was to examine categorization differences between experts and novices and to examine whether categorization training has positive effects on problem solving. The results from Experiment 1 suggest that experts classified problems based on deep structures related to problem solution methods whereas novices classified problems based on surface features. When the deep structures of problems were explicitly presented to novices, however, their categorization pattern was not different from experts'. The results from Experiment 2 suggest that categorization training increases novices' problem solving performance whereas solution training is more effective for experts'.

Our findings suggest that different training methods should be applied according to expertise and initial performance level because experts and novices have different representations of problems. Categorization training is effective for novices to acquire the ability identifying deep structures of problems, while solution training in which learners solve problems repeatedly is an effective way for experts.

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