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Experimental Investigation on Effects of Explanation Activities on Improvement of Creative Ideas

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Abstract. In the present study, we investigate the effects of explanation activities on creative idea generation. In our experiment, in Phase 1, the participants were required to design furniture from given parts with pencil and paper. The products designed in this phase were called pre-products. In Phase 2, the participants explained their products in the explanation condition. In the control condition, the participants engaged in thinking about innovative furniture instead of explaining it. Last, in Phase 3, the participants were required to design innovative furniture by revising their own pre-products. The products designed in this phase were called post-products. The pre- and post-products were rated from the viewpoint of originality and practicality. Increase of practicality from pre- to post-products was more salient in the explanation condition than increase in the control condition. This result suggests that explanation activities contribute to maintaining high practicality while generating high originality ideas.

Keywords: creative idea generation, creative cognition, creativity, explanation activity

1 Objective

We sometimes find innovative ideas while explaining familiar things to others. For example, Johannes Kepler, the noted astronomer, got his insight about the mathematical structure of the universe, which was a decisive point of his lifework, while drawing a diagram on a blackboard in a university lecture. In the present study, we investigate the effects of explanation activities on creative idea generation based on a cognitive psychological experiment.

Studies on creativity began to increase in the 1950's. Various research methods have been used; one empirical way of investigation is the creative cognition approach that adopts a technique that clarifies the mental representations and processes underlying creative idea generation (Lubart and Sternberg, 1995). The creative cognition approach is an experimental psychological research method led by Finke, Ward, and Smith (1992). Finke (1990) is one traditional laboratory study on creativity. In this study, participants engaged in a creative instance generation task in various experimental conditions, and the quality of the products created in each condition was rated. This series of researches identified the factors of the situations from which innovative ideas emerge.

On the other hand, many studies have investigated the effects of explanation activities in learning processes. Studies of self-explanation have concluded that understanding learning contents is promoted by generating explanations about them while engaging in the task (Chi, Bassok, Lewis, Reimann, and Glaser, 1989). Many empirical studies have indicated the positive effects of explanation activities on learning process in various domains and types of participants. However, the effects of explanation on creative activities have not been clarified. In the present study, we investigate the effects of explanation activities on creative idea generation.

2 Method

2.1 Participants

One hundred and thirty-two undergraduates participated in the experiment. Those who did not follow instruction or produced nothing were excluded from analysis. As a result, the number of participants was 111.

2.2 Task

In our experimental task, participants were required to design furniture on paper by combining the parts presented to them. This task was modified from a creative generation task used in Finke (1990), which is one representative experimental task used in many preceding studies on creativity. In our experiment, the participants designed two products before explanation

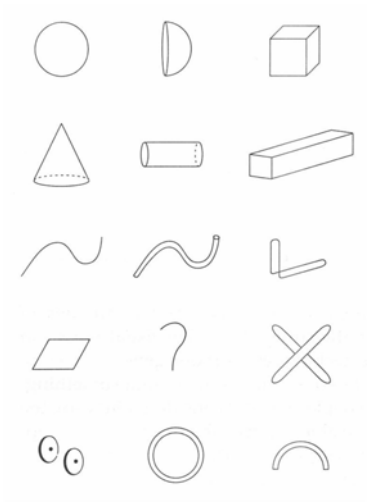

Fig. 1. Set of parts

and after.

2.3 Procedure

The experimental procedure was as follows:
Phase 1 (pre-test): Participants were required to design furniture from given parts (see Figure 1) with pencil and paper. The products designed in this phase were called pre-products.
Phase 2: The participants explained their products under various constraints that were experimentally manipulated. In the control condition, the participants engaged in thinking about innovative furniture instead of explaining it.
Phase 3 (post-test): Finally, the participants were required to design innovative furniture by revising their own pre-products. The products designed in this phase were called post-products.

The experimental groups were organized by manipulating the explanation activity in Phase 2 by the experimenter's instructions. Four experimental and one control conditions were set up.
Normal explanation (writing/oral): Explaining products normally as furniture intended in Phase 1. The explanation was written on a paper or orally presented to the other person.
Explanation as innovative furniture (writing/oral): Explaining products as newly designed innovative furniture that was. The explanation was written on a paper or orally presented to the other person.
Control condition: Thinking about innovative furniture instead of explaining in Phase 2.

Table 1 shows the number of the participants in each condition.

Table 1. Number of the participants in each condition

	writing	oral
Normal explanation	26	17
Explanation as innovative funiture	17	19
Control	53	

2.4 Judging products

2.4.1 Judging naive creativity
The pre- and post-products were rated from the viewpoint of creativity based on the CAT method (Amabile, 1983). The number of products analyzed, created by the 111 participants, was 222. A total of 158 undergraduates did the judging; and each product was rated by thirteen to eighteen evaluators.

The judges rated the products from the viewpoint of creativity on a seven-point scale: (1) not creative at all to (7) very creative. . Interrater agreements were assessed using Kendall's coefficient of concordance for each group in which the evaluators estimated an identical set of products. Their Kendall's W ranged from .18 to .50 ($p<.01$, all of them). The avarage score of all judges for each product was called "naïve creativity score."

2.4.2 Judging originality and practicality
The pre- and post-products were rated from the viewpoint of originality and practicality based on the Finke's method (Finke, 1990). Eight undergraduates and graduate students did the judging. Four judges rated all products from the viewpoint of originality and the other four judges from the viewpoint of practicality. Prior to the rating, strict criteria were given to each evaluator. The judges rated the products using a four-point scale. Interrater agreements were assessed using Kendall's coefficient of concordance in originality ($W=.53$, $p<.01$) and practicality ($W=.48$, $p<.01$). The avarage score of the four judges in originality rating was called "originality score" and the average score of the four judges in practicality rating was called "practicality score."

3 Results

The improvement scores from pre to post test in each judging were used in following analysis.

3.1 Comparing results among experimental conditions

To investigate the effects of ways of explanation (writing or oral) and the instruction in explaining (normal or innnovative), two (way of explanation as a between-subjects factor: oral and writing) x two (instruction as a between-subjects factor: normal and innovative) ANOVAs were performed on the improvements of the naïve creativity, the originality and the practicality scores. Table 2 shows the means of the improvement of the naïve creativity scores in the experimental conditions. In the analysis of the impronements of the naïve creativity scores, neither the main effects (way of explanation: $F(1, 65) = .00$, n.s.; instruction: $F(1, 65) = .19$, n.s.) nor the interaction between the two factors ($F(1, 65) = .80$, n.s.) was significant.

Table 3 shows the means of the improvements of the originality and the practicality scores in experimental conditions. In the analysis of the improvements of the originality scores, neither the main effects (way of explanation: $F(1, 65) = .01$, n.s.; instruction: $F(1, 65) = .31$, n.s.) nor the interaction between the two factors ($F(1, 65) = .23$, n.s.) was significant. In the analysis of the improvements of the practicality scores, neither the main effects (way of explanation: $F(1, 65) = .81$, n.s.; instruction: $F(1, 65) = .47$, n.s.) nor the interaction between the two factors ($F(1, 65) = .83$, n.s.) was significant.

These results suggest that there were no effects of ways of explanation and the instruction in explaining on creative idea generation. In the following analysis, we integrated all experimental conditions as a unified explanation condition.

3.2 Comparing results among the explanation and control conditions

3.2.1 Analysis in each judging

Table 4 shows the means of the improvements of the creativity, the originality and the practicality scores.

To investigate the effects of the explanation activity, unpaired t-tests were performed in the improvement of each score between the explanation and control conditions. In the analysis of the improvements of the naïve creativity scores, there was no significant difference between the explanation and the control condition ($t(109) = 1.12$, n.s.). To investigate whether the mean improvements of each condition in the naïve creativity scores was significant, the mean improvement of the naïve creativity scores in each condition was compared with zero as the baseline by using one sample t-tests. The mean improvements of both conditions were significant (Explanation condition: $t(68) = 6.74$, $p < .001$; control condition: $t(41) = 6.02$, $p < .001$).

In the analysis of the improvements of the originality scores, there was no significant difference between the explanation and control conditions ($t(109) = 1.23$, n.s.). The mean improvement of the originality scores in each condition was compared with zero as the baseline by using one sample t-tests. The mean improvements of both conditions were significant (Explanation condition: $t(68) = 4.97$, $p < .001$; control condition: $t(41) = 4.58$, $p < .001$). On the other hand, in the analysis of the improvements of the practicality scores, there was a significant difference between the explanation and control conditions ($t(109) = 2.25$, $p < .05$). The mean improvement of the practicality scores in each condition was compared with zero as the baseline by using one sample t-tests. The mean improvement of control condition was marginally significant ($t(41) = 1.81$, $p = .078$), whereas the mean improvement of the explanation condition was not significant ($t(68) = 1.30$, n.s.). This result indicates that the degree of practicality decreased only in control condition.

These results indicate that explanation activity

Table 2. Mean improvements of the naïve creativity scores in the experimental conditions

		Naïve creativity score
Normal explanation	writing(n=25)	0.67 (SD=0.69)
	oral(n=15)	0.51 (SD=0.80)
Explanation as innovative funiture	writing(n=15)	0.44 (SD=0.54)
	oral(n=14)	0.59 (SD=0.78)

Table 3. Mean improvements of the originality and the practicality scores in the experimental conditions

		Originality score	Practicality score
Normal explanation	writing(n=25)	0.32 (SD=0.49)	0.09 (SD=0.39)
	oral(n=15)	0.27 (SD=0.50)	0.09 (SD=0.26)
Explanation as innovative funiture	writing(n=15)	0.33 (SD=0.60)	0.12 (SD=0.48)
	oral(n=14)	0.41 (SD=0.69)	-0.07 (SD=0.52)

Table 4. Mean improvements of the naive creativity, the originality and the practicality scores in the explanation and control conditions

		Originality and practicality judging	
	Naïve creativity score	Originality score	Practicality score
Explanation condition (*n*=69)	0.57 (*SD*=0.70)	0.33 (*SD*=0.55)	0.07 (*SD*=0.42)
Control condition (*n*=42)	0.73 (*SD*=0.78)	0.48 (*SD*=0.67)	-0.12 (*SD*=0.43)

Table 5. Number and ratio of participants in each category in the explanation and control conditions

	Both scores improved	Only originality score improved	Only practicality score improved	No improvement
Explanation condition (*n*=69)	17 (0.25)	27 (0.39)	12 (0.17)	13 (0.19)
Control condition (*n*=42)	6 (0.14)	22 (0.53)	5 (0.12)	9 (0.21)

contributes to maintaining high practicality while generating high originality ideas.

3.2.2 Analysis by combining originality and practicality

We categorized the participants into four groups based on their improvements of the originality and the practicality scores: (1) "Both scores improved" where the participants improved both the originality and the practicality scores, (2) "Only originality score improved" where the participants improved only the originality score, (3) "Only practicality score improved" where the participants improved only the practicality score, and (4) "No improvement" where the participants improved neither the originality nor the practicality scores. Table 5 shows the distribution of the participants categorized into each category.

To compare the distribution of the "Both scores improved" between the explanation and control conditions, a two (explanation / control) x two (Improved both scores / others) Fischer's exact test was performed. There was no significant difference in the distributions between the two conditions (p= .143, one-tailed).

4 Disussion

Our experimental results suggest that explanation activities contributes to maintaining high practicality while generating high originality ideas.

Chi (2000) suggested that the self-explanation activity promotes elaborating mental models of learning contents explained. In our study, the explanation activity might promote elaborating mental models of products, and for that reason the practicality was maintained in the explanation condition.

On the other hand, no effect of explanation activities in originality was detected because the increase of the originality scores in the explanation condition did not exceed the increase in the control condition. This implies that it is necessary to investigate the effects of explanation activities on the creative idea generation in more realistic situations: e.g., expert participants explain their familiar knowledge in a natural context.

Our future work is to analyze expert verbal protocols and interview data to clarify expert creators' processes of idea generation.

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