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EFFECT OF MEMBERS' PROFESSIONAL DIVERSITY IN GROUP ON CREATIVE THINKING

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ABSTRACT
In this study, we experimentally investigated the effect of members' professional diversity in a group on creative thinking, by adopting a new evaluation method of group creativity. The creative thinking is a process of developing creative ideas, both original and effective ideas. According to some past literatures, it is generally believed that the professional diversity is one of the important factors for promoting group creativity, but such diversity effect is not sufficiently studied yet. In order to clarify the effect of the professional diversity, four diverse and four non-diverse groups conducted creative thinking tasks. Participants were either art or engineering students. Group creativity was evaluated by generation ratio of creative ideas instead of the number of generated ideas. As the result, the effect of the diversity appeared in the tendency of the quality of selected ideas in each group and members' individual idea generation. However, the effect of the diversity did not appear in the generation ratios of creative ideas sufficiently. To understand mechanism of the effect of the diversity, we analysed members' verbal interaction in a group in creative thinking. It seems that there is a correlation between members' utterances and the quality of selected ideas. Also, it is suggested that the diversity does not affect group creativity sufficiently by mainly participants' lack of understanding of the difference of majors. In order to take advantage of the professional diversity, creative thinking should be designed so that members can understand each other's professional difference and make use of their expertise.

Keywords: Group diversity, Members' professional diversity, Creative thinking

1 INTRODUCTION

In recent competitive markets, many industries have been required to develop new ideas, in other words, creative ideas. Creativity is defined as the development of novel ideas that are useful [1]. Creative thinking is a process to use creativity. The creative thinking is consisting of complicated combination of the sub-processes: divergent thinking for generating ideas and convergent thinking for assessing generated ideas [2].

They usually perform the creative thinking in groups. Creativity in a group generally is called group creativity. Thus, it is important to promote the group creativity for efficient creative thinking. Members' diversity in a group is one of the important factors to promote the group creativity [3-5].

The members' diversity can be divided into two categories: bio-demographic diversity and task-related diversity. The bio-demographic diversity represents innate member characteristics that are observable and categorised (e.g., age, gender, and race/ethnicity.) The task-related diversity is acquired individual attributes (e.g., functional expertise, education, and organisational tenure.) The bio-demographic diversity does not have impacts on group performance. In contrast, the task-related diversity affects group performance positively [6]. One of the task-related diversity is group members' professional diversity. The professional diversity is proven to affect the financial value of innovations [7]. However, the professional diversity's effect on creative thinking has not been investigated sufficiently. Its main cause is difficulty of evaluation of group creativity.

Although the group creativity is often evaluated by the number of ideas generated in a group, it considers only the divergent thinking not the convergent thinking under the context [2]. To evaluate the group creativity, it is necessary to evaluate creativity of ideas developed through both of the divergent thinking and the convergent thinking. Barki and Pinsonneault [8] said that creativity of an idea can be evaluated by averaging Likert-type scales [9] of three criteria: the idea's originality,

effectiveness and feasibility. However, originality should be prioritised in order to satisfy the definition of creativity. Thus, it is necessary to introduce a new originality-prioritised evaluation method instead of the average method. A creative idea should be both of highly original and highly effective.
Additionally, it is necessary to analyse members' interaction in creative thinking to understand mechanism of the effect of the professional diversity. The creative thinking is performed through the members' interaction, especially verbal interaction. Nevertheless, the interaction has not been studied sufficiently. The members' verbal interaction can be analysed by observing members' utterances.
In this paper, we experimentally investigated the effect of members' professional diversity on group creativity. The group creativity was evaluated by the generation ratio of creative ideas in each group with using the new evaluation method. In addition, the mechanism the effect of the professional diversity was analysed the members' verbal interaction in creative thinking. The new evaluation method and the analysis of the utterance are based on the redefinition of creativity as developing original and effective ideas.

2 METHOD

2.1 Creative thinking tasks for experimental verification of the effect of members' professional diversity

2.1.1 Objective and participants

Two groups of four engineering students who belong to engineering laboratories (Eng.) and four art students or alumni (Art) conducted fewer than two different conditions of group organisation shown as table 1. A diverse group was composed of two engineering participants and two art participants. A non-diverse group was composed of four either engineering or art participants.

Table 1. Two conditions of the experiment

	Condition in Task 1	***Condition in Task 2***
Eng. 1-4, Art 1-4	Diverse	Non-diverse
Eng. 5-8, Art 5-8	Non-diverse	Diverse

2.1.2 Materials

A group conducted a creative thinking task in the area shown as figure 1 (a). An example of the design outcome of the task is shown as figure 1 (b). Each participant used a black pen, a set of 90 small pieces of papers, three-colour sticky notes (red, green, blue).

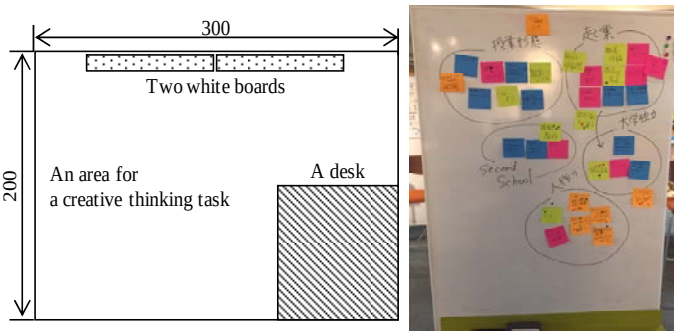

Figure 1. (a) An area for a creative thinking task (b) an example of white boards

2.1.3 Procedure of the creative thinking task

The creative thinking task consisted of six steps shown as table 2. The goal of the task is making a summary of one idea as a group.
First, participants were informed of criteria of creativity (originality, effectiveness, feasibility) and rules of brainstorming. After that, they conducted first creative thinking task about topic A: "Redesign a vending machine." After taking ten-minute break, they conducted second creative thinking task about topic B: "Redesign a study conduct in a university."

Table 2. Overview of the creative thinking task

Steps	***Description***
Ice breaking 5 min	Participants introduced themselves with each other to reduce their tension in each group.
First idea generation 10 min	Each group generated ideas about the topic using Osborn's method [10]. They were instructed to write their one idea on their one sticky note and put sticky notes on white boards.
Classification 5 min	Each group classified ideas into categories and give names to the categories.
Second ides generation 10 min	Each group generated ideas about the same topic based on the first idea generation outcome in the same way as first idea generation.
Evaluation and Vote 5 min	First, members individually evaluated originality, effectiveness and feasibility of ideas. After that, each group selected one from their ideas based on the members' individual evaluation.
Making a summary of an idea 5 min	Each group described the selected idea by text and sketches.

2.1.4 Analysis 1: calculation of generation ratio of creative ideas of each group

Criteria of the evaluation were originality (the criteria that the idea is novel, out of ordinary), effectiveness (the criteria that the idea helps to solve the problem) and feasibility (the criteria that the idea is precise and the ease with which it can be implemented, given the current context).

Evaluation objects were ideas that were highly valued by members in the step of "Evaluation and Vote." Creativity of ideas was evaluated by the following method:

1. Ideas were evaluated based on originality, effectiveness and feasibility on 5-point Likert-type scales by three experts.
2. If at least one of three experts gave score of four or more to both originality and effectiveness and value of three or more to feasibility, the idea was a creative idea.

We calculated ratio of creative ideas to all generated ideas in a group with using the following equation:

$$r = N_c/N, \tag{1}$$

where r is the generation ratio of creative ideas of the group, N_c is the number of creative ideas of the group and N is the number of generated ideas of the group. We compared the generation ratios of creative ideas of diverse and non-diverse groups for each topic to eliminate members' learning effect by repeating the same process of creative thinking. In the comparison, the group members were not unified, but members' personal difference were assumed not to appear in the quality of ideas because creative thinking in a *group*.

2.1.5 Analysis 2: observation of creative thinking tasks

We observed the effect of the members' professional diversity by generated ideas, voice data and video data of the creative thinking tasks.

2.2 Analysis of members' verbal interaction

We analysed how members' utterance changed as idea generation progresses. The utterance was evaluated based on contexts and contents from the following point of view: whether each member put weight on each of the criteria (originality, effectiveness and feasibility) when the member generated each utterance.

Table 3. Coding criteria

Categories	***Coding criteria***
Originality	When trying to generate ideas, when concerning about whether an idea is novel
Effectiveness	When talking about a current problem or situation with feeling problem, when talking about a value of an idea
Feasibility	When concretising a generated idea, when talking about how to make an idea available to users

For the analysis, we set coding criteria of each originality, effectiveness and feasibility as table 3. In order to verify the reliability of the coding criteria, two people evaluated sample data of one group by using the coding criteria. Reliability factor of coding criteria of originality (κ_o), effectiveness (κ_e) and feasibility (κ_f) were values shown as table 4.
Using the coding criteria, we analysed each member's utterances in idea generation steps.

Table 4. Values of the reliability factor of each coding criteria

The reliability factors	***Values***
Originality, κ_o	0.770
Effectiveness, κ_e	0.672
Feasibility, κ_f	0.503

3 RESULT

3.1 The effect of members' professional diversity

3.1.1 Generation ratio of creative ideas in each group

Figure 2 shows the tendency of quality of selected ideas as the ratio of evaluated ideas which have high scores in term of originality, effectiveness and feasibility. At this point, "ideas which have high scores" means that the maximum score among three experts' evaluation is four or more. Figure 3 is a graph focusing on the tendency of quality of the selected ideas of engineering group and the diverse groups of Eng. 1-4 and Art 1-4 in table 1.
Figure 4 shows the generation ratio of creative ideas. This graph compares the generation ratio of non-diverse group (Art group and Engineering group) and diverse group for each topic. About figure 4, art groups more likely to generate creative ideas than other groups.

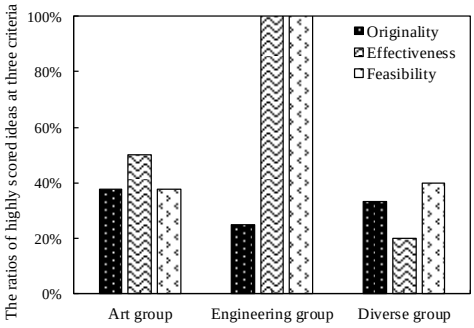

Figure 2. The tendency of quality of selected ideas (Eng. 1-8 and Art 1-8)

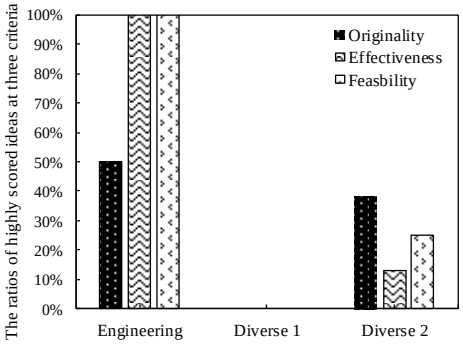

Figure 3. The part of the tendency of quality of selected ideas (Eng.1-4 and Art 1-4)

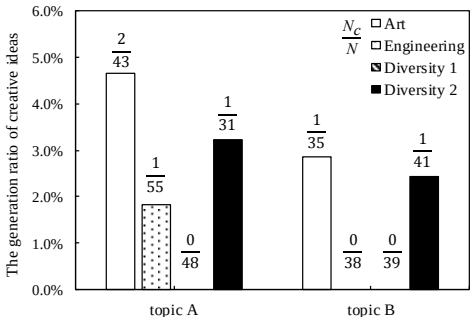

Figure 4. The generation ratios of creative ideas

3.1.2 Observation of creative thinking tasks

In a creative thinking task about topic A ("Redesign a vending machine"), two ideas shown as idea (a) and (b) in table 5 were generated in a diverse group.

Table 5. Generated ideas in a diverse group

Ideas	***Contents***	***Generator***
Idea (a)	"Design of a vending machine changes day by day"	An Art
Idea (b)	"My original design of a vending machine can be called up"	An Eng.

3.2 Members' verbal interaction in idea generation

In figure 3, the difference between the results of engineering group and diverse group is remarkable. Thus, we focused on the engineering members' utterances in figure 3, shown as figure 5. About figure 5, the engineering group more likely to care about originality and feasibility than diverse groups in 1st idea generation. In 2nd idea generation, the engineering group more likely to care about effectiveness than diverse groups.

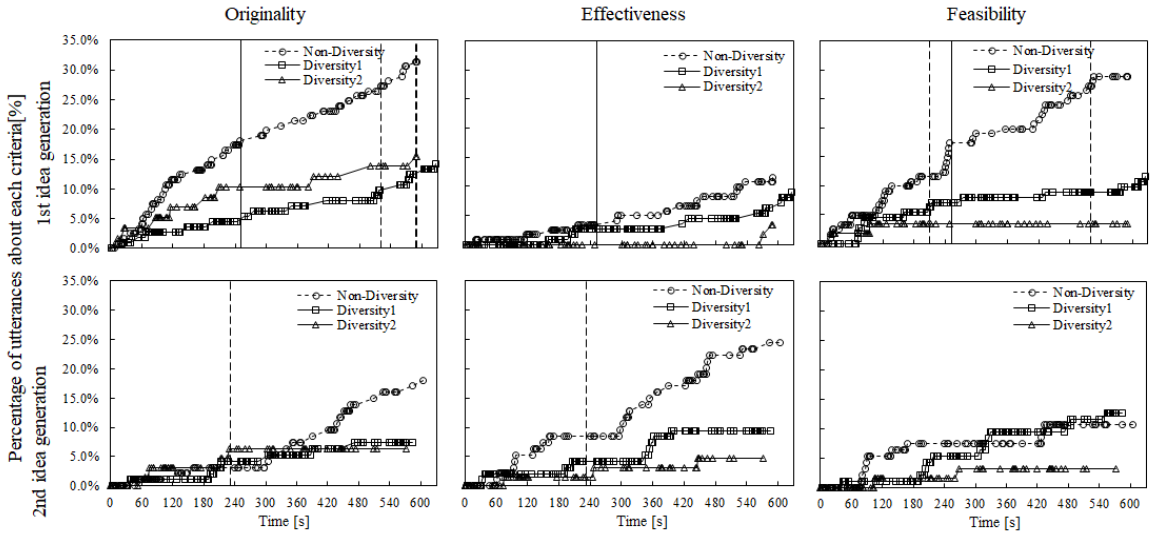

Figure 5. Change of the engineering members' utterances in idea generation steps
The graphs shows the percentage of engineering members' utterances about each criterion in all utterances of each group. The upper graphs are about first idea generation, and the lower are about second idea generation. Vertical lines in the graphs represent the moment of generating ideas which highly scored in the each criteria of creativity

4 DISCUSSION

According to figure 2, engineering groups are more likely to select effective or feasible ideas than art groups and diverse groups. On the other hand, art groups are more likely to select original ideas than engineering groups and diverse groups. These tendencies are caused by the differences of thinking between engineering and art. Engineering people tend to care about functions and effectiveness of ideas because they usually work on manufacturing. Art people usually focus on creating new things. Thus, the engineering group seems to be good at generating highly effective and feasible ideas, and the art group seems to be good at generating highly original ideas. If these differences are advantage in a diverse group, selected ideas in the diverse group may be more original, effective and feasible than ones in a non-diverse group. However, the professional diversity prevents the expertise of engineering and art because such tendency is not appear in the figure 2.

About figure 4, the generation ratios of creative ideas have no correlation with the professional diversity. However, effect of factors other than the diversity (e.g. personal difference, experiential difference) includes the generation ratios of creative ideas. Thus, it is necessary to do further experiments to exclude these effects and verify only the effect of the diversity.

According to figure 5, engineering members tend to generate utterances about originality and effectiveness in non-diverse groups rather than diverse groups. The vertical lines appear around 240 seconds in five of the six graphs. It is probably because members in the groups got used to idea generation steps at this time.

Although the effect of the diversity is not significantly observed quantitatively, the effect of the diversity is observed in generated ideas qualitatively. About table 5, the idea (a) is about design of a

vending machine, and expertise of art can be observed in it. 56 seconds after the art member generated the idea (a), an engineering member in the diverse group generated the idea (b). This is a typical case that the diversity promotes individual idea generation because an art member inspired an engineering member.

According to figure 3 and figure 5, it seems that there is a correlation between the utterances and the tendency of quality of the selected ideas in the case of the engineering group and the diverse groups. In other words, the diverse group is less likely to generate original, effective and feasible ideas than non-diverse group because the diversity may hinder the members from generate utterances about originality, effectiveness and feasibility. The participants' lack of understanding of the difference of majors is one of the reasons that the diversity affects on utterance generation negatively. Enough time is necessary to make use of the professional diversity because some observation suggests that the diversity affects creative thinking positively in long term [11]. In this paper, the creative thinking task was 40 minutes. It is suggested that the time length is too short for members to understand and accept each other's professional difference. Therefore, the diversity affected the group creativity negatively. It is necessary to design creative thinking process that members can understand and accept each other's professional difference to make use of the effect of the diversity in short-term.

5 CONCLUSION

In this paper, we experimentally investigated the effect of the members' professional diversity on group creativity. The group creativity was evaluated by creativity of ideas measured with using a new evaluation method. Members' verbal interaction in creative thinking was analysed for understanding the mechanism of the effect of the professional diversity. As the result, the effect of the professional diversity appeared in the tendency of the quality of selected ideas in each group and members' individual idea generation. The diversity affected on the tendency of the quality of selected ideas negatively. On other hand, the case was observed that the diversity affected on the individual idea generation positively. However, the effect of professional diversity did not appear in the generation ratios of creative ideas sufficiently. Also, it seems that there is a correlation between members' utterances and the quality of selected ideas. It is suggested that the professional diversity does not affect group creativity sufficiently by mainly participants' lack of understanding of the difference of majors. In order to take advantage of the professional diversity, creative thinking should be designed so that members can understand each other's professional difference and make use of their expertise.

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