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Workshop design for enhancing the appropriateness of idea generation using analogical thinking

Eunyoung Kim

Human Life Design Area, School of Knowledge Science, Japan Advanced Institute of Science and Technology, 1-1 Asahidai, Nomi, Ishikawa 923, Japan

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ABSTRACT

As technologies advance and replace human labor in a variety of settings, we focus our attention on human creativity for generating new ideas. Business organizations, more than ever, recognize that they need employees who think creatively to maintain their competitive edge. Nonetheless, there is a lack of research assessing new ideas and influential factors in generating innovative ideas. The aim of this study is to identify the factors that influence the creation of innovative ideas. We conducted two different types of workshops with 22 subjects and 23 subjects each. In the first workshop, subjects were asked to generate new business ideas through analogical thinking. As a result, half of the participants generated appropriate ideas, and three influential factors were determined: categorization skill, deliberation, and trial and error. The second workshop was designed to facilitate participants to enhance these three factors. As a result, 70% of the participants could generate appropriate ideas. By identifying influential factors, this paper suggests a procedure for designing an innovation workshop that enables the creation of appropriate ideas.

1. Introduction

Recent cutting-edge technologies have changed our attitudes and behaviors toward our jobs and daily lives. Moving into the new era, researchers have extensively studied how humans acquire knowledge and generate new ideas (Finke, 1989; Medin, 1989; Sawyer, 2011). Further, many academic institutions deliver innovation workshops to help create new ideas. The dictionary definition of creation is "the act of making or producing something that did not exist before." However, if new ideas were produced from nothing, it would be impossible to explain the cognitive process of idea generation. Creating a new idea, no matter how surprisingly novel it is, should not be regarded as something magical or the result of divine inspiration (Sternberg, 1988).

Despite the huge amount of interest surrounding the generation of new ideas, there are few studies that focus on defining the appropriateness of new ideas and the factors that enhance the appropriateness of new ideas. In this paper, we first seek to review several studies that highlight the role of analogical thinking in generating ideas and then define appropriateness in the context of newly generated ideas. Then, we describe four cognitive procedures in idea generation through analogical thinking—acquiring knowledge, conceptualization, creative leap, and trial and error. Finally, we empirically investigate factors influencing the generation of appropriate ideas by conducting two types of workshops.

E-mail address: kim@jaist.ac.jp.
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2. Appropriateness of new ideas generated through analogical thinking

Analogical thinking is the cognitive process of transferring information or meaning from the source to the target (Gentner & Markman, 1997; Glynn, Britton, Semrud-Clikeman, & Muth, 1989; Holyoak & Lu, 2010). This section describes the role of analogical thinking in idea generation and the appropriateness of generated ideas.

2.1. Role of analogical thinking in idea generation

Metaphors are often invoked while explaining analogical thinking. Both analogies and metaphors express comparisons and highlight similarities; however, they do this in different ways (Duit, 1991). An analogy explicitly compares the structures of two domains; it indicates the identity of structural components. A metaphor compares implicitly, highlighting features or relational qualities that do not coincide in two domains. However, the carrying over of merely surface features, without a structural similarity to underpin them, may lead to a false analogy, and consequently, to a wrong solution to a problem (Goldschmidt, 1995, pp. 53–74). Holyoak et al. (2010) defined analogical thinking as focusing on abstract relational categories. The power of analogical thinking helps import structure from a well-articulated domain into a less coherent domain, revealing their common structures (Gentner et al., 1997).

There is a lack of empirical studies that examine how and to what extent analogical thinking influences creative thought. However, according to several existing studies on methods for generating new ideas, analogical thinking has the greatest theoretical support as a key driver for stimulating innovative ideas. As a consequence, researchers across major disciplines accept the premise of previous studies (Clement, 1981; Goel, 1997; Hofstadter, 2008; Holyoak and Thagard, 1996) that analogical thinking plays a central role in innovation and creativity.

2.2. Appropriateness of generated ideas

Despite tremendous efforts, researchers have been dissatisfied with the definitions of terms regarding the evaluation of new ideas, such as originality, creativity, innovativeness, or effectiveness. The complexity of “ideas” has long been acknowledged; indeed, it is one of the most difficult psychological constructs to define and measure (Hocevar, 1981). Innovation certainly requires some level of originality, but not the maximum level of novelty. Rather, a maximum level of originality can be regarded as mental illness (Runco, 2014). Appropriate new ideas are required to be useful and novel in some respect (Bruner, 1979). In extant empirical research, usefulness or some other quality of ideas, has been posited as an indicator of appropriateness (Harrington, Block, & Block, 1983; Milgram, Milgram, Gaby, & Rabkin, 1978; Mobley, Doares, & Mumford, 1992; O'Quin & Besemer, 1989; Yamamoto, 1965).

In this paper, we focus on the appropriateness of ideas generated through analogical thinking. In generating ideas through analogical thinking, the quality of ideas is conceived and operationalized in terms of two distinct dimensions: superficial and structural similarities (Blanchette & Dunbar, 2000; Dunbar & Blanchette, 2001). If ideas are created based on a structural similarity with source ideas, this increases the likelihood of benefitting from effective source mechanisms. However, this approach does not guarantee the appropriateness of generated ideas. It is necessary to maintain a structural similarity whilst achieving only superficial differences with respect to existing sources. Therefore, in this study, a new idea that has high structural similarity and low superficial similarity with existing cases is defined as an appropriate idea (Kim & Horii, 2015, 2016).

2.3. Cognitive procedures in idea generation through analogical thinking

There are a number of process models that describe the creative procedures involved in idea generation (Bransford & Stein, 1984; Burnard et al., 2006; Gordon, 1961; Isaken, Dorval, & Treffinger, 2000; Kelley, 2001; Scott, Leritz, & Mumford, 2004; Sternberg, 2006, pp. 79–104). The procedures in these models comprise two to eight steps. The simplest model is described in terms of divergent and convergent thinking. Going further, the integrated model includes problem identification, knowledge acquisition, information gathering, incubation, idea generation, combination, evaluation, and externalization. This study focuses on how people can be facilitated to create appropriate ideas. In this regard, we selected the following four key stages as instructions for the purpose of designing a workshop: acquiring knowledge, conceptualization, incubation and creative leap, and trial and error.

2.3.1. Acquiring knowledge

Boden (2004) outlined that creativity can occur in three ways: combination, exploration, and transformation. Among these three types, the majority of human creativity can be explained by combinations. Perkins (1981) asserted that creative insights occur from analogies by recognizing similarities or retrieving something we are aware of.

Although creativity researchers accepted the importance of acquiring knowledge as the preparation stage, internalizing substantial knowledge does not always result in creative ideas (Sawyer, 2003). There is controversy concerning the level of knowledge required to create new ideas in a certain domain. Gardner (2011) conducted an extensive case study on seven exceptional creators and found that ten years of study in a domain is a prerequisite to make a creative contribution. However, some researchers claim that the quantity of acquired knowledge is not correlated with creative performance (Nijstad, Stroebe,

& Lodewijkx, 2002). Moreover, some studies found that too much knowledge might hinder the creation of new ideas. Simonton (1984) posited an inverted-U function, whereby beyond some critical level of education, additional formal education impedes creativity rather than improving it. Frensch and Sternberg (1989) noted that knowledge in a field can cause one to have a closed view and continue to follow previous ways.

2.3.2. Conceptualization by categorization

There have been many studies that suggest that categorization is significantly related to analogical reasoning (Bowdle & Gentner, 2005; Gentner et al., 1997; Hesse, 1966; Holyoak & Thagard, 1997; Sternberg, 1977). Categorization is believed to arise from exposure to relevant exemplars and deep, elaborative processing intended to reveal the central features or common properties of members in the category (Chi, Bassok, Lewis, Reimann, & Glaser, 1989; Schmeck & Grove, 1979; Ward, Byrnes, & Overton, 1990). These categories and the associated examples are used in problem solving through analogical thinking based on specific cases drawn from the activated categories (Gick & Holyoak, 1983; Medin, 1989). Holyoak and Lu (2010) defined analogical thinking as focusing on abstract relational categories. Analogical thinking involves mapping a set of correspondences between elements of the source and the target, which are possible members of a category in terms of their structural relations.

2.3.3. Incubation and creative leap

After acquiring knowledge and conceptualizing accordingly, all the information or knowledge needs to be processed to create new ideas. While taking time for idea generation, many creators might have a moment of sudden illumination, which is called a "creative leap," "Ah-ha moment," or "Eureka." During the process of idea generation, thoughts and ideas are combined automatically, unconsciously, and rapidly (Bargh & Morsella, 2008; Strack & Deutsch, 2004). This stage is called "incubation," and many researchers have illuminated good examples of the importance of taking time off from focused work to engage in another activity (Sawyer, 2011). However, many studies have found that when people face complex problems, they tend to focus on familiar ideas rather than making an effort to think creatively (Collins & Loftus, 1975; Mednick, 1962; Tversky & Kahneman, 1974).

2.3.4. Trial and error

Trial and error, also called "Generate and test" or "Iteration" is a weak method in problem solving, which does not require substantial knowledge of the problem structure (Klahr & Simon, 1999). It is similar to a process of trying each key, one by one, from a box of keys to find the key that fits the lock. Many researchers found iterative shifting activities in new product and service development or innovation-related problem solving (Kolb, 2014; Kristensen, 1992; Sosna, Trevinyo-Rodríguez, & Velamuri, 2010; Tyre and von Hippel, 1993; Von Hippel & Tyre, 1995). Csikszentmihalyi and Getzels (1988, pp. 91–116) conducted research to identify the creative process of fine art painters. Subjects were instructed to choose and rearrange objects in a studio and draw them. The artists were divided in two groups: type one and type two. The type-one artists took only a few minutes to choose a few objects among the 27 objects presented, and they sketched an overall composition in a couple of minutes. The type-two artists spent five to 10 min looking at the 27 objects, turning them around to observe them from all angles. Even after sketching the objects, they changed their minds, put the objects back and chose alternatives; 20 or 30 min later, they came up with another idea. After an hour, they settled on an idea and finally finished sketching in five or 10 min. A team of five professors in the Art Institute judged the type-two paintings to be far more creative than those made by the type-two artists. Moreover, five years after the graduation of the participants, they traced all 31 of these students and found that all successful artists were from the group labelled type two.

Facilitating trial and error helps one find new combinations, reach the creative leap stage, and understand the process of generating new ideas that might initiate innovations. Thus, in this study, we designed workshops that encourage one to enhance thinking skills and create appropriate ideas.

3. Workshop I: identifying influential factors for generating appropriate ideas

Workshop I is designed to investigate specific influential factors that help generate appropriate ideas through analogical thinking.

3.1. Participants

In total, 22 university students (15 male, 7 female) from 14 different countries participated (see Fig. 2). Participants were recruited from students enrolled in related courses of the Department of Engineering and students registered via our mailing list.

3.2. Workshop procedure

The main topic of the workshop in this study was to create business ideas based on collective intelligence. According to an often-cited definition, collective intelligence is a form of universal, distributed intelligence, which arises from the

collaboration and competition of many individuals (Lévy, 1997). With the rapid growth of the information technology industry, the collective intelligence service has received much attention in the field of innovation.

Workshop I consisted of a preparatory task and two main tasks. The preparatory task required acquiring knowledge on existing business cases. All subjects were asked to read the case material of 25 collective intelligence services including well-known services such as Amazon as well as services that the participants were unfamiliar with but that were popular in Japan. The first main task was a categorization task for understanding the underlying mechanisms of the existing services. The second main task was an idea generation task for creating new service ideas using analogical thinking based on the categorization created in the previous task. Each participant was asked to create new service ideas using analogical thinking, sourcing from the title of the category as well as the selected cases according to his or her preference. Subjects were required to complete both, the categorization and generation tasks, within 1 h for each task with a 15-min break between the tasks. The categorization task was facilitated by a group discussion, while the generation task was to be completed individually. After the workshop, face-to-face interviews were conducted with participants to reveal their creative leap moments during the idea generation session.

3.3. Settings

The workshop was held in our studio equipped with six shared monitors that could be connected to participants' laptops via APISNOTE, a bespoke software specifically developed for our workshop. Subjects were asked to bring their own laptop to the workshop. While carrying out the tasks, all notes with the actual time of their creation are automatically recorded in APISNOTE. Because all the notes created by participants were recorded in “hh:mm:ss” format, we could analyze the thinking process based on the content of notes produced from the tasks. Further, the workshop was video-recorded with a 360-degree camera that could read the face of each participant (see Fig. 1).

3.4. Measures

As mentioned in subsection 2.3, the workshops in this study were designed based on the four stages in cognitive procedures: acquiring knowledge, conceptualization by categorization, incubation and creative leap, and trial and error. Using the recording apparatus, participants' data were collected through all the workshop procedures except the knowledge acquiring stage, which was assigned as a preparatory task to the participants. To understand how each step influenced the appropriateness of the generated ideas, we coded all the collected data and analyzed them as follows.

To evaluate participants' performance in the categorization task, exemplary categorization needs to be presented to act as a benchmark. We asked four researchers in the innovation science study group of the University of Tokyo to categorize the 25 cases individually. They created 26 category labels in total, and those labels were classified into four groups through cluster analysis: 1) Crowdsourcing; 2) Human computation; 3) Social computing; 4) Data mining. In addition, this classification was supported by related research on the classification of collective intelligence (Quinn & Bederson, 2011). Consequently, if a participant categorized cases in a manner that accorded with 70% or more of the exemplary categorization, his or her performance was assessed as “high.”

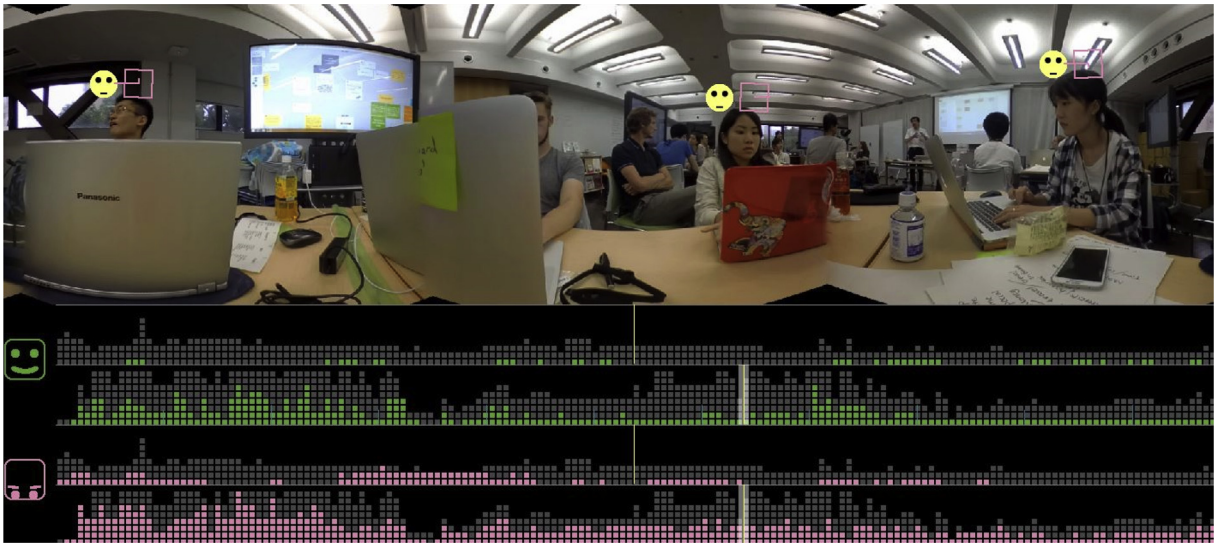

Fig. 1. Setting for the workshop: A panoramic view of the group.

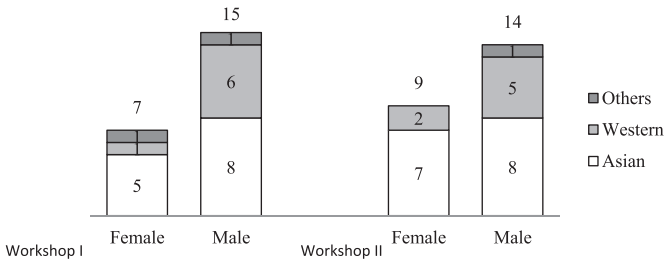

Fig. 2. Participant demographics.

After the workshop, the subjects were asked to retrace their ideation process using the cues provided by APISNOTE, showing the history of the ideation process along with the time-stamped notes they created during the workshop. They were then asked to indicate the creative leap stage with reference to a specific note. Consequently, the degree of deliberation was defined as the number of notes created by a participant before reaching the creative leap divided by the total number of notes created.

The degree of trial and error was measured by the number of domains considered for generating the final new idea. If a subject considered more than three domains, the degree was assessed as "high." Moreover, if subjects deleted their previous notes more than five times before converging on the domain from whence their new idea was generated, they was regarded as having "high" trial and error.

The importance of evaluating the appropriateness of the generated ideas must be noted. There exist numerous studies on new idea evaluation; however, a majority of them are dependent on subjective judgment of plural evaluators (Dean, Hender, Rodgers, & Santanen, 2006; Rogers & Adhikarya, 1979). This study examined the superficial and structural similarities to evaluate the appropriateness of ideas generated through analogical thinking. Gentner et al. (1997) claimed that the power of analogical thinking is to reveal common structures and to import structure from a well-articulated domain into a novel domain. Consequently, the appropriateness of a new idea is evaluated in terms of superficial and structural similarities. Structural similarities were judged in the same way as those used for assessing the performance of participants in categorization. We investigated if the new ideas could be categorized under any category of the source cases. Superficial similarities were measured by semantic similarity between the domains of source cases and the created idea using a latent semantic analysis application (http://lsa.colorado.edu). To compute semantic similarities of the domains between the sources and the new idea in the corresponding structure, keywords clearly describing services or targeting users were selected.

4. Results

In this study, the idea generation task was performed individually; thus, the unit of analysis is each individual. Among 22 participants, 20 generated their new idea individually. Therefore, $n = 20$ for the purpose of data analysis. The participants created 22 notes on average for the generation task (min = 12, max = 41, SD = 8.5).

From the face-to-face interviews conducted for all participants, it was revealed that five participants exhibited low levels of deliberation, whilst the other 15 participants had high levels of deliberation before reaching the creative leap moment.

Ten out of 20 of the generated ideas were assessed as appropriate ideas. As we can see from the results, analogical thinking does not always promote the generation of appropriate ideas. Among the ten participants who failed to generate an appropriate idea, five of them were able to import the structural features from the source cases. However, they were unable to apply them to the new domains, which are superficially far from the existing domains. The other five subjects failed to apply the underlying structures of any source cases.

As shown in Table 1, among the three factors considered in this study, the performance in the categorization task approached the borderline of significance ($p = 0.0678$), whilst the other two factors exhibited significant relationships with respect to the appropriateness of generated ideas.

Further, as we noticed from the results, two-third of the participants failed to use trial and error to identify the domain for their new idea during the idea generation task. Of course, it is not easy to generate a new idea that exhibits a deep structural similarity but with little superficial similarity vis-à-vis the sources ideas. However, the findings in this study provide insights for developing workshop design methods to encourage participants to take additional steps to maximize the likelihood that appropriate ideas are generated.

5. Workshop II: proposing a workshop design that enhances the appropriateness of generated ideas

The goal of conducting Workshop II is to determine whether outcomes from the workshop are a function of workshop design. Because the methodology of this workshop is similar to that of Workshop I in various respects, we only highlight the differences in this section.

Table 1
Relationships between influential factors and the appropriateness of generated ideas.

Influential factors	No. of subjects	Evaluation of generated ideas				Chi-square	p value
		Appropriate	(%)	None	(%)		
1. Performance in categorization task						3.3333	0.0678
High	12	8	66.7%	4	33.3%		
Low	8	2	25.0%	6	75.0%		
2. Deliberation before the creative leap stage						6.6667	0.0098
High	15	10	66.7%	5	33.3%		
Low	5	0	0.0%	5	100.0%		
3. Trial and error						6.6667	0.0098
High	5	5	100.0%	0	0.0%		
Low	15	5	33.3%	10	66.7%		

5.1. Participants

Twenty three university students (14 male, 9 female) from ten different countries participated in this workshop. Participants were recruited from students enrolled in related courses of the Department of Engineering and students registered via our mailing list. Participants were informed about the goal of the workshop in the same way as Workshop I.

5.2. Workshop procedure

According to the result of Workshop I, there are two main factors that significantly enhance the appropriateness of ideas generated using analogical thinking: deliberation before reaching the creative leap moment and trial and error in finding the problem domain. Therefore, Workshop II was designed to encourage participants to take advantage of those two factors.

The settings for this workshop are the same as Workshop I. However, an additional task was given to the subjects before being instructed to use an analogy table for the generation task. Subjects were given 15 min and asked to generate five different, new ideas that were as diverse as possible in terms of business domains. To help the subjects conjure diverse ideas, 38 possible domains were presented in text format for their reference, such as marriage and house reform (see Fig. 3). Further, subjects were asked to choose one idea from the notes and generate the final new service idea using the analogy table.

6. Results

Seventy per cent of the subjects who participated in Workshop II generated appropriate ideas, compared to 50% in Workshop I (see Fig. 4). The evaluation matrix consists of superficial and structural similarities between the new ideas and the existing ideas in our samples. As mentioned previously, new ideas are expected to maintain structural similarity for their effectiveness, but should be superficially different from existing cases for their novelty or newness.

By including an additional task, Workshop II increased the participants' level of deliberation, before reaching the creative leap moment, from 75% to 91% (see Fig. 5).

More importantly, the additional task enhanced participants' use of trial and error as a mechanism for finding a domain from wherein a new idea could be generated. In Workshop II, 96% of the participants exhibited a high degree of trial and error, compared to 25% in Workshop I (see Fig. 6). Participants' interview transcripts provided specific evidence of the positive contribution of the additional task in Workshop II, which presented exemplary domains for new ideas before generating the

Fig. 3. Domain cards presented for the additional task.

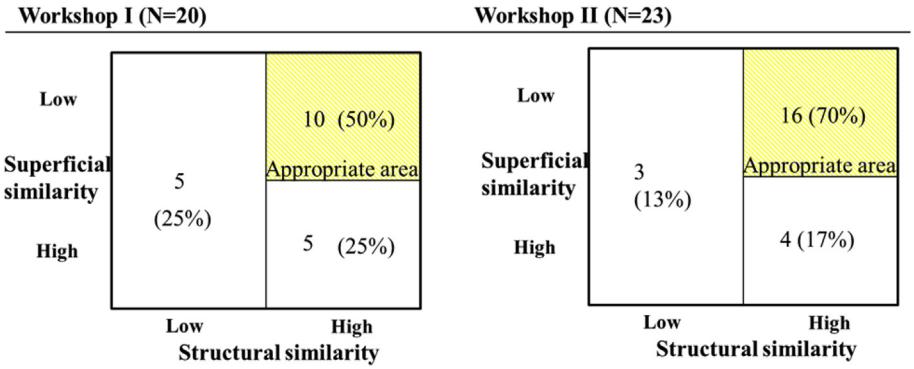

Fig. 4. Comparison of results from workshops I and II.

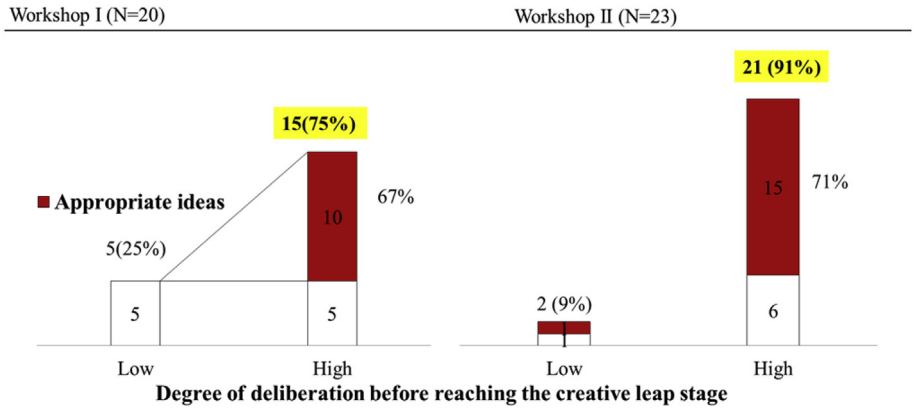

Fig. 5. Comparison of participants' degree of deliberation between workshops I and II.

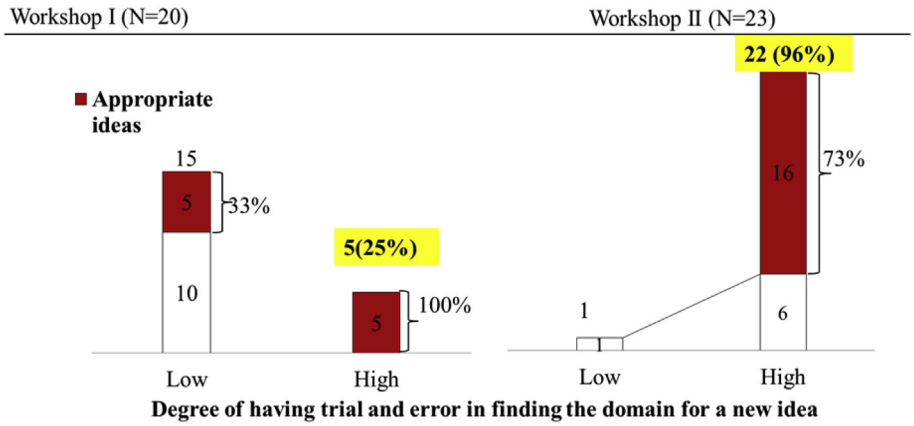

Fig. 6. Comparison of participants' degree of trial and error between workshops I and II.

ideas using analogical thinking. Selected interview quotes from participants who generated appropriate ideas have been mentioned below:

> "I wrote about business structure in the white notes, and I made new ideas by combing these white notes with each domain card. To create new ideas, I tried to mix a couple of business domains here together, so I mixed 'Job' + 'Housing', and then came to think of my new idea, 'house finder', for people who get a job in a new place." - participant 5B

Table 2
Comparison of the Outcomes from Workshop I and II vis-à-vis Low Performers and High Performers in the Categorization Task.

	No. of subjects	Evaluation of generated ideas				Chi-square	p-value
		Appropriate	(%)	None	(%)		
Low performers in the categorization task						3	0.08326
Workshop I	8	2	25.0%	6	75.0%		
Workshop II	16	10	62.5%	6	37.5%		
High performers in the categorization task						0.83	0.3631
Workshop I	12	8	66.7%	4	33.3%		
Workshop II	7	6	85.7%	1	14.3%		

> "After having a bunch of ideas revolved around once or twice in a lifetime decision, I realized there is value in algorithms to learn from feedbacks and repeated decision making." - participant 6A

> "I came to think of it by the combination of artisanal methods and advanced manufacturing techniques." - participant 6D

To test the effectiveness of the additional task in Workshop II on enhancing the appropriateness of generated ideas, it is important to compare the results of the untreated factor, that is, the categorization skill of the participants. As shown in Table 2, there is a borderline significant relationship ($p = 0.08$) between workshop type and the appropriateness of ideas generated among low performers in the categorization task. Categorization skill is often equated with the level of knowledge (Gabrilovich & Markovitch, 2006). Therefore, we can conclude that the procedure followed in Workshop II would be more beneficial for individuals who do not have good domain-relevant knowledge.

7. Discussion and conclusions

This study aimed to identify influential factors that enhance the appropriateness of generated ideas by observing participants' thinking processes. Our results show that deliberation before reaching the creative leap stage as well as trial and error in finding a business domain can significantly increase the chance of generating appropriate ideas through analogical thinking. Based on the results of our study, innovation workshop program designers should consider the use of cues for allowing subjects to contemplate and permit trial and error to generate new ideas. In our workshop, the aim was to generate new business ideas based on collective intelligence. Beyond business ideas, the focus could be new product development or dealing with social issues.

Many existing studies on new idea generation have been led by cognitive psychologists or educational psychologists. In these studies, the subjects were often asked to solve problems such as Duncker's radiation problem (Duncker, 1945) or the Tower of Hanoi puzzle (Hinz, 1989). In contemporary society, there is an increasing need to create new business ideas. In response to this, business organizations, more than ever, recognize that they need employees who think creatively to maintain their competitive edge. In response to this, a large number of companies are delivering creativity training programs as a means to enhance innovative thinking among their employees. This study offers a new perspective for understanding the thinking process in creating appropriate ideas, facilitated via workshops that anyone can participate in regardless of their domain knowledge.

One limitation of our study, however, is that we did not validate the evaluation method we proposed. Another limitation is the small sample size. Recruiting volunteers for a 4-h long workshop without any compensation was challenging. Participants were recruited with different backgrounds and from different sources; this made it difficult to determine a date for the workshop that would optimize attendance. Moreover, by way of further restriction, subjects were required to speak and write fluent English and to spend extra time on reading the case study material as a preparatory task. As a result of these practical constraints, we only had 45 participants in total. It is important for future studies to reinforce or refute our findings in the context of a larger sample of participants.

We identified three influential factors—categorization skill, deliberation, and trial and error—by conducting Workshop I. Based on these findings, we proposed an additional task in Workshop II to encourage subjects to reinforce these factors for the purpose of generating more appropriate ideas. We observed improvement in the appropriateness of the generated ideas in Workshop II, especially for those participants who exhibited low levels of domain-relevant knowledge.

The goal of this paper is not to teach readers how to generate new ideas. Rather, we are interested in understanding the thinking process involved in generating new ideas and how participants can be facilitated in generating appropriate ideas by designing and implementing certain workshop procedures. Further work is required to explore the explanatory power of alternative influential factors and the mechanisms by which these factors can be harnessed to improve our way of generating new ideas.

Conflicts of interest

The authors declare no conflict of interest.

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