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Idea Storming Cube: A Game-based System to Support Creative Thinking

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Abstract

This paper describes a collaborative game-based creativity support system, Idea Storming Cube, in support of creative thinking. It aims to make people form a creative and perspective-shift thinking habit. The system acquires knowledge from domain expert, user inputs history, and individuals in the current brainstorming group, and then provides user-, goal- and context-sensitive supports. Comparing to classic tutoring systems, it focuses more on stimulating divergent thinking. The system can be put into the Basic Mode or the Idea Generation Mode in order to support different gaming objectives. A case study for preliminary evaluation of the proposed HCI tool for collaborative idea generation is also reported in this paper.

1. Introduction

Creating an inspiring environment, possibly with the mechanism of a game, is crucial for enhancing the motivation and effects of learning. In this paper, we aim to build a collaborative game-based environment called *Idea Storming Cube* to support production of creativity. The environment refers to a creativity framework of software implementation from Shneiderman [3]. Based on Csikszentmihalyis's theory of creativity [1], we also take various perspectives of creativity support into account in the proposed system. These perspectives include *social idea support from teammates*, *domain background knowledge from experts,* and the *idea generation capacity of each individual,* as shown in Figure 1. We model and monitor the process of creative idea generation among these perspectives.

Group Support System (GSS) is considered as another effective technology to generate ideas of a greater quantity. Some researchers [5] found that GSS are more advantageous to support the generation of *Paradigm-Preserving* (PP) ideas than the *Paradigm-Modifying* (PM) ideas. In this work, we try to enhance the mechanism of GSS for creativity learning, especially in perspective-shift learning support.

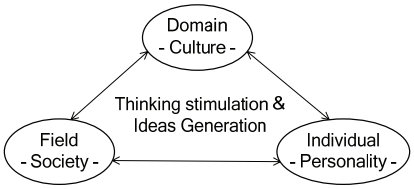

Figure 1: Csikszentmihalyi's model of creativity [1]

In an unstructured knowledge creation environment, Cyert [2] argued that people only have sequential, limited attention and processing capability toward goals in their thinking process. We think that the current technologies developed for large-scale information retrieval (IR) (e.g., web searching) are still far from an ideal supportive tool for creativity. How the system provides user- and context-sensitive supports, and how we factor out the task characteristics are all key issues in dealing with bounded rationality [4], which are underemphasized in the current IR systems.

In the system proposed in this paper, we would like to consider the problems of (1) how to build a creativity support system including different perspectives from domain, field, and individuals, (2) how to stimulate users in generating more paradigm-modifying ideas, (3) how to help users reduce information noise and provide assistance in an iterative and incremental manner to arouse new ideas.

2. Idea Storming Cube: An Online Group Creativity Support Tool

We have developed a tool, named *Idea Storming Cube (ISC)*, to support creativity production. The ISC system works like an online poker game requiring 2 to 6 par-

ticipants. The major steps in the process are described as follows:

1) Before the game starting, each one uploads *Topic Writing*, a text file for the given discussion topic.
2) Every user is given a 3x3 array of cards, maybe filled with ideas generated by others.
3) The system asks a user to generate new ideas and then fill them into the blank cards.
4) After contributing a good new idea, one is allowed to exchange cards with others' by rotating a column or a row of the cube to see cards with new ideas.
5) Finally, a user wins if he/she has generated the largest amount of valid cards in a given time.

2.1 Brainstorming with User Profile Contrast Agent (UPCA)

We use a simplified model of formal User Profile (*fUP*), proposed in our previous work [6], to model domain knowledge for a particular idea generation task. Each simplified *fUP* is a finite set: $fUP = \{I_1, I_2, ..., I_m\}$, in which I_i represents a specific idea possessed by the user. More specifically, the *Domain fUP,* denoted as fUP_d , is a fUP developed by a panel of domain experts to capture ideal solutions for the given task, and serves as a fundamental component for the system in performing automatic support [7]. The collection of individual fUPs and fUP_d will be integrated into a conceptual space called *Field-Domain fUP* (*FD_fUP*) in which $fUP_i, i = 1...n$ denotes the profile of user *i*:

$$FD\_fUP = fUP_d \cup fUP_1 \cup ... \cup fUP_n$$

It can be reused for subsequent runs and continually updated from the results of pervious brainstorming. In our design, users will not be given all information in the brainstorming activity because we hope that each user can watch different subsets of the problem such that they can relate issues in the current context to create new idea or think of solutions from different aspects. In order to know which idea is the most suitable for each user, we have developed the *User Profile Contrast Agent* (*UPCA*) for this task. By computing the cosine similarity between word vectors [7], UPCA compares all fUP's to derive the differential sets of ideas among brainstorming peers. For example, if we want to know what part of the ideas owned by User B is what User A does not know, we can compare fUP_A and fUP_B with the following formula:

$$fUP_{I_b} = (FD\_fUP - fUP_A) \cap fUP_B$$

We hope that UPCA can create appropriate cognitive stimulations [8] in the brainstorming activities of User A, because it can solve the disorder problem that a communicative type of information system may have. Furthermore, it is possible for UPCA to stimulate a user with concepts of totally different perspective from several users.

2.2 Learning Strategies: Basic Mode versus Agent-Assisting Mode

Our system provides two different strategies: *Basic Mode* (BM) and *Agent-Assisting Mode* (AAM), where the latter one uses a virtual agent to manipulate the brainstorming activities. The ideas of the two mode and their targeting portions of the ideas in FD_fUP are illustrated in Figure 2:

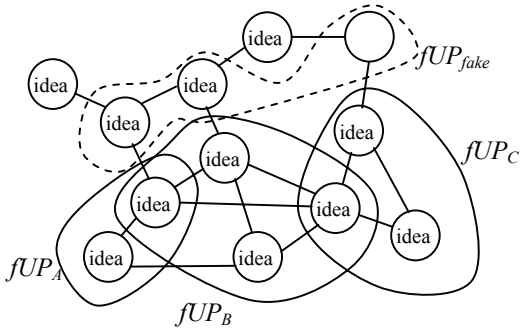

Figure 2: Different learning strategies in ISC: BM and AAM

In the basic mode, the goal is for the users to share their understanding of the domain with their peers. Therefore, in each run of the game, the ISC system identifies what a user has learned according to his/her fUP and presents new ideas from his/her teammates such that all team members can learn to understand all the ideas that have been accumulated in the idea storming activities. For example, for user U_A in Figure 2, the target portion of FD_fUP falls on the ideas of U_B and U_C that are already owned by U_A. Likewise, when getting a chance to exchange ideas, U_B will be exposed to the idea owned by U_A and U_C.

In the agent-assisting mode, the system encourages users to produce more perspective-modifying thoughts. We use a fake user U_{fake}, a perspective-modifying thinker, to take the real users away from their original thinking box. The fUP of U_{fake} is a subset of FD_fUP that does not intersects with any of the fUP's (fUP_i, i=1,2…n) of the real users, as expressed in the following formula:

$$fUP_{fake} \subseteq FD\_fUP - \bigcup_i fUP_i$$

As depicted in Figure 2, fUP_{fake} is a dynamic set that is updated during the activity according to the ideas that have been created by the users. The objective is to collaboratively explore different parts of the FD_fUP such that the overlap between individual fUPs can be minimized for productivity and efficiency.

3. Use case

We demonstrate the use case scenario in the Basic Mode for learning the conceptual knowledge of *Debris Flow Hazard* problem. After multiple players log on the cube, each player first submits his/her ideas by uploading a text file containing the initial ideas about the possible causes of debris flow. These initial ideas are used to build FD_fUP with the domain knowledge collected from experts.

After the game starts, each user is arranged to face one side of the cube, and asked to input as many ideas (causes of debris flow) as possible. When a novel idea is recognized, the user will be allowed to rotate a row or a column of the cube to exchange ideas with others. A user can gain credits by creating novel ideas by himself/herself or by rotating in the ideas of other users as the reward of contributing a new idea. The winner would be the one who gets most credits in a given period of time. Therefore, each player will strive to be productive in idea generation in order to win the competition.

In the competition, the system only prompts the user the possible rotations that he/she can make to attain new ideas. The final decision on what to rotate to acquire more inspiring ideas from others still relies on the users. For example, if a user 'John' has inputted a novel idea, John will be allowed to rotate the cube once with the suggestions arrows for possible rotations from the system. Similarly, the cube will also suggest others to take away this new idea card by John when they get a chance to rotate the cube.

In Figure 3, we show the interface where John entered a novel idea in the upper middle cell and the suggestion arrows for exchanging this node will be shown in another user's (Mary) window. As soon as the user inputs a novel idea, he/she will get a chance to rotate this node into the current view. Therefore, the system encourages the users to input their ideas as quickly as possible such that the contributed ideas can be considered "novel" at that moment. By limiting the view of a user to a few ideas, the user can concentrate on generating related ideas based on the current view. In other words, the system makes use of the concept of rational boundary to increase the quality of generated ideas, and it also uses the cube mechanism to gradually change the view to inspire new ideas.

John *Mary*

Figure 3: A user gets another's idea card by rotating a row

4. Conclusion

In this research, we try to design a game-based tool to support creativity learning and perspective-modifying thinking. Based on the theory of rational boundary, we design the system to expose limited view of the whole domain to the user to infer related ideas. The cube rotation mechanism allows a user to exchange ideas with other user in order to promote diverged perspective-modifying thinking. Two modes are used to provide different strategies for exploring new ideas. The system runs as a game to increase motivation and encourage efficient and effective production of novel ideas.

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