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Design Creativity Education: Cognitive Elements of Creativity and an Affective Model for Personalized Learning

JongHo SHIN, Yong Se KIM
Creative Design Institute, Sungkyunkwan University, Suwon Korea
jonghoshin@skku.edu
yskim@skku.edu

Abstract: In this work-in-progress report we present a design creativity exercise program which addresses cognitive elements of creativity and an affective model, as an effort to provide learners the opportunity of enhancing design creativity in a personalized adaptive manner. The personalized needs in specific elements and dynamically changing affective states are addressed in the creativity exercise program. Employing the experiment log data, we are using data mining approaches in understanding the relations among various characteristics of learners and their learning experiences.

Keywords: Cognitive Model, Affective Model, Design Creativity, Learning, Data Mining.

1. Introduction

As in general creative activities, design process involves both divergent and convergent thinking processes. Promotion and maximization of the generation of ideas were pursued for enhancing the design creativity [1, 4]. While both vertical and lateral thinking approaches have been identified as used by designers [2], a recent research showed the importance of the commitment mode control strategy in creative designing capabilities [5].

Design creativity cannot simply be defined by only the capability to produce novel and useful ideas. It is important to establish concrete components of design creativity and to find distinct cognitive processes for design problem solving so that education of design creativity could be attempted based on the identified distinct cognitive processes. It is meaningful to further decompose the design creativity into its cognitive elements which are highly related to design thinking ability. Furthermore, it would be desirable if there exists a systematic exercise program to foster design creativity addressing those cognitive elements.

In addition, personal adaptation is important in terms of user learning. A learning user model includes both static and dynamic characteristics of learners [6] and especially, the personal adaptation can be supported through affective modeling which establishes dynamically changing parameters of user emotions.

We have conducted research work towards design creativity education so that various underlying cognitive elements and processes of design creativity are identified, along with affective states. These design creativity elements and processes can be enhanced through training methods reflecting individual learner's cognitive personal characteristics, such as visual reasoning capability which identified as a critical element of design creativity [7].

We discuss our findings and provide an outlook to the coming work in our research, organized as follows: The cognitive elements of creativity are presented in Section 2. The affective model is in Section 3. The exercise program and experiment are described in Section 4. The discussion and future work in Section 5.

2. Cognitive Elements of Design Creativity

In the study, the fundamental cognitive elements of creativity were devised and used throughout the designed creativity exercise program, aiming to improve the design creativity of learners. Details about the program are elaborated in Section 4. The cognitive elements of design creativity have been defined based on Treffinger's creative learning model [9]. The Treffinger's creative learning model encompassed the cognitive and affective aspects. The cognitive aspects in Treffinger's creative learning model are fluency, flexibility, originality, elaboration, and cognition and memory. We replaced cognition and memory with problem sensitivity, and identified five cognitive elements of design creativity:

- **Fluency** is an ability to make multiple answers to the same given information in a limited time [3] and quantity of meaningful solutions [10].
- **Flexibility** is an adaptability to change instructions, freedom from inertia of thought and spontaneous shift of set [3]. That is the mode changing categories [10].
- **Originality** is rarity in the population to which the individual belongs; its probability of occurrence is very low [3, 10].
- **Elaboration** is the realization or transformation of an idea, which may become very general or simple or in contrary very fantastic or enriched into details [10].
- **Problem Sensitivity** is an ability to find problems [10] and to aware needs for change or for new devices or methods [3].

3. Affective Model

In order to measure dynamic characteristics of learners during the creativity exercise program, and to investigate its relationships with the 5 cognitive elements of creativity, we incorporated an affective model which consists of eight states; joy, acceptance, apprehension, distraction, sadness, boredom, annoyance, and anticipation. The affective model was identified based on the basic emotion categories proposed by Plutchik [8].

In the context of computer-assisted learning of creative design capabilities, affective modeling of learner is done in a self-reporting format with a pop-up diagram. The online form of dialog representation provides learners one or more affective states for selection during experiment. Note that the affection capture diagram uses identical icons so that other influences than affective state selection could be isolated in the interaction of the diagram and the users.

4. Creativity Exercise Program

We devised a creativity exercise program which fosters the enhancement of cognitive aspects of the design creativity, grounded on the definition of cognitive elements of creativity in Section 2. The creativity exercise program consists of 5 tasks, that differ in the level (high, medium, and low) of addressed cognitive elements. We hypothesized that the enhancement of underying cognitive aspects of design creativity can be achieved by the creativity exercise program which consists of 5 tasks with the addressed cognitive elements. The details of the 5 tasks of the creativity exercise program are as follows:

(1) Making Stories: The 'making stories' exercise asks learners to produce different stories using three different pictures by changing the order of them. Therefore, this activity aims to improve the flexibility cognitive element. The elaboration element can also be developed through this activity by implying cause and effect of given pictures and specifying them. Originality can be enhanced through the activity to make unique and novel stories.

(2) Negation: In the 'negation' exercise, the learners are asked to compulsively and purposely negate the given objects. In this activity, the learners are supposed to negate a chair and a

shopping basket and make new ideas about them. As a result, the fixed views or ideas on the objects can be broken, and the learners can find the different and potential aspects of the objects. In this way, this activity can help to make new objects and transform original objects. This program aims to develop flexibility and originality.

(3) Filling Black Box: The objective of 'filling black box' is to mainly develop fluency by logically addressing the connections between the given input and output concepts as many times as possible within a limited time. This activity can develop elaboration by explaining the logical relations of input and output concepts. The originality can additionally be enhanced by discovering distinctive connections between given input and output concepts.

(4) Sensitization: In the 'sensitization' exercise, the learners are asked to express their feelings on the given physical objects and abstract concepts according to five different senses. In this activity, the problem sensitivity can mainly be developed to dig out potential characteristics of the given objects or concepts. In addition, this activity aims to develop the flexibility by describing concrete feelings on abstract concepts from the view of five senses.

(5) Diverse Classification: The final activity is the 'diverse classification' exercise. In this activity, the learners are asked to classify the given objects in several different ways. Therefore, the flexibility can be mainly developed by considering diverse criteria to group the given objects in a different fashion. In addition, this activity aims to develop the problem sensitivity to understand the multiple characteristics of given objects.

5. Discussion & Future Work

This work-in-progress paper has put forth a design creativity education incorporating both static and dynamic characteristics of learners. Forty four senior or first-year graduate students from the Interdisciplinary Design course (Spring, 2010) at the Sungkyunkwan University participated in the program. The log data collected from the experiment are being analyzed by emplying data mining approaches, such as associatin rules and decision tree learning. We expect to discover detailed relations among various characteristics of students and their learning experiences in this exercise program. One of the preliminary results indicates that students in non-negative affective states achieved enhanced design creativity in comparison with students in negative affective states (distraction, sadness and apprehension) during the experiment. Adaptation to user characteristics and to user affective states will be realized in a form of recommendation based on the data mining results, in which personalization is provided for learners.

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