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An Instructional Model with an Online Support System for Creative Problem Solving

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This study examines the possibilities of an integrated instructional model in a collegiate course using Creative Problem Solving with an online support system. An integrated instructional model was developed to enhance the creativity of college students. The principles and guidelines of the model were analyzed by the formative research methodology. General design principles were identified by reviewing the literature, and then theoretical components for the model were extracted. Finally, specific guidelines from those design principles and theoretical components were developed. Those guidelines were implemented into a college-level course with 33 students in 'A' university. The number of the final interviewees was 10. The participants' responses were analyzed to investigate the strengths, weaknesses, and improvements of the model. Further studies are suggested to develop an optimal instructional model using the repetitive formative research methodology and to examine the effects of the instructional model by conducting an empirical study are suggested.

Keywords: creativity, creative problem solving (CPS), online support system, integrated instructional model

INTRODUCTION

Courses to enhance creativity have recently appeared as relatively new subjects in the college environments. Most studies of creativity up to now have focused on the young students ranging from kindergarten to junior high school. However, college students, who would be facing the complex problem-solving situations in their careers, need to have better creative skills. Regarding the creativity, the Creative Problem Solving (CPS) is one of the most frequently referred conceptual models. CPS is understood as a structured methodology for enhancing the creative thinking of the individuals and teams. The CPS model emphasizes a balance between the divergent and the convergent thinking in every step of the problem solving process (Puccio, Murdock & Mance, 2005).

Among the various CPS models that have emerged through several decades of studies, this study was based on the CPS version proposed by Treffinger and his colleagues (2000). Their model consists of eight stages: 'Appraising tasks', 'Designing process', 'Constructing opportunities', 'Exploring data', 'Framing problems', 'Generating ideas', 'Developing solutions', and 'Building acceptance (Treffinger, Isaksen, & Dorval, 2000).

The purpose of this study is to develop an integrated instructional model in a college course using the Creative Problem Solving with an online support system. The formative research methodology is used to improve the principles and guidelines of the model.

THE ORETICAL BACKGROUND

Creative Problem Solving

Creative Problem Solving is a model to solve problems in the problematic circumstances by the repetitive use of divergent and convergent thinking (Lee & Lee, 2007). The balance between these two kinds of thinking in every step of the problem solving process is a critical factor for the CPS.

CPS has emerged through the past several decades of work. The descriptions Osborn (1963) proposed have become the fundamentals of CPS. Parnes (1977) developed Osborn-Parnes model with five stages by revising Osborn's initial framework. Isaksen and Treffinger (1985) added the sixth stage to Osborn-Parnes model. Through the studies in the 1980s and 1990s, the process and structure of CPS have been developed in details. The referred CPS models include Osborn-Parnes' model (Parnes, 1977), Isaksen & Treffinger's model (Isaksen & Treffinger, 1985; Treffinger et al., 2000), and Puccio, Murdock & Mance's model (Puccio et al., 2005).

Among these models, Isaksen and Treffinger's model and Treffinger and his colleagues' model are the most frequently referred conceptual models. Treffinger and his colleagues (2000) suggested a CPS model with four components, which can be classified into two major categories: *a management component and a process component*. The management component consists of 'Planning Your Approach', containing two stages of 'Appraising Tasks' and 'Designing Process'. This management component serves as an operating system to guide the application of the three process components, 'Understanding the Challenge', 'Generating Ideas', and 'Preparing for Action'. These process components are composed of six specific stages, during which creative and critical thinking abilities are used in harmony. The followings are those six stages: 'Constructing Opportunities', 'Exploring Data', 'Framing Problems', 'Generating Ideas', 'Developing Solutions', and 'Building Acceptance' (Treffinger et al., 2000).

The most outstanding characteristic of CPS is the repetitive use of divergent and convergent thinking (Puccio et al, 2005). Divergent thinking facilitates generating various creative solutions in the process of CPS (Lee & Lee, 2007). Convergent thinking is a skill to determine the solutions by focusing on many possible ideas deliberately, and evaluating them (Kim, 2008). Therefore, for the successful application of CPS, it is critical to use both thinking skills appropriately and flexibly (Firertien, 1982). There are many techniques within the stages of CPS to enhance the divergent and convergent thinking skills (Kim, 2008; Lee & Lee, 2007). Kim (2008) classified various thinking tools into the divergent and convergent thinking tools. For instance, brainstorming, forced connection method, morphological analysis, Osborn's checklist, attribute listing, and SCAMPER are classified as the divergent thinking tools. On the other hand, the convergent thinking tools include hits, highlighting, reverse brainstorming, evaluation matrix, paired comparison analysis, ALU (Advantage, Limitation, and Unique Qualities), and PMI (Plus, Minus, and Interesting).

Teaching Creativity

Courses for creativity have been mostly focused on the CPS model with young students, ranging from kindergartens to junior high schools. However, college students who would have to solve the complex problems in their workplace are in greater need for the creative skills. Creativity courses for college students in Korea could be classified into two kinds: one is a 'teaching creativity course', with its main goal as teaching creativity itself; the other is a 'creativity-integrated course', in which the topics of the course are also taught while the students are involved in the creative problem solving process.

Regarding the 'teaching creativity course', Park (2004) taught creativity in his liberal-arts course of 'Understanding and Enhancement of Creativity', and reported that the course was effective in general. Jeong (2003) designed a 'Developing Creativity' program for a liberal-arts course to examine the effects of a creativity program and the learning styles, such as an individual and cooperative learning. The results demonstrated the improvement of students' creativity and effectiveness of cooperative learning. On the other hand, as an 'creativity-integrated course', Baek and his colleagues (2006) implemented an 'Imaginative Design Engineering' course to measure and develop the creativity of the college students. The study found that the TTCT (Torrance Tests of Creative Thinking) score of the participants has increased.

Recently, more attentions are held to the blended learning environments for the creative problem solving (Graham, 2006). Lee and Lee (2007) developed a blended instructional model for the CPS and integrated an online and face-to-face learning environment in the formation of a 'Blended instructional model for Creative Problem Solving'. In this study, they tried to enhance the CPS skills based on the premise that the online modes offer a learning environment for the divergent thinking and the offline modes provide a

learning environment for the convergent thinking. The researchers developed the blending principles by analyzing CPS models and reviewing the literature about the blended learning.

Most previous studies on creativity have been focused on young students. Moreover, those are mostly about teaching creativity course in a classroom setting. Those studies have not focused much on the creativity-integrated courses for college students with an online support system in a blended learning environment. Therefore, this research aims to develop the principles and guidelines for an integrated instructional model in a college course using the Creative Problem Solving with an online support system.

RESEARCH METHOD

Formative Research Methodology

This research consists of two parts: developing an instructional model by reviewing the relevant literatures and examining the strengths, the weaknesses and the improvements of the model by the formative research methodology. The formative research methodology is a kind of developmental research that is intended to improve design theory for designing instructional practices or processes. It is a methodology suggesting with the focus on the prescription and is introduced as one of the qualitative methodologies (Lim, 1999; Reigeluth & Frick, 1999).

Developing an Instructional Model

An instructional model was developed by following three steps: discerning the general principles from reviewing the relevant literature; extracting theoretical components for the model by categorizing those general principles; and finally, developing a set of specific guidelines for each principle from the viewpoint of these theoretical components. The instructional model also included such components as e-Learning contents and an online support system.

The online support system was developed based on the CPS model proposed by Treffinger and his colleagues (2000). The system guides the CPS process and provides convergent and divergent thinking tools such as brainstorming, attribute list, hits, PMI, and evaluation matrix. Each stage within the system provides one divergent thinking tool that facilitates generating ideas and two convergent thinking tools.
The online support system also allows students to write the reflective journals. This offers them opportunities to reflect on their learning activities while experiencing the online CPS process.

Improving the Instructional Model

A college-level course was developed and implemented to examine the strengths, the weaknesses and the improvements of the model by the formative research methodology. Research site was an undergraduate course in ‘A’ university. It was sixteen-week-course with 33 students and students were divided into 4 teams. 12 students, 3 students from each team, were selected as interviewees considering the level of participation: 4 students with high participation, 4 students with low participation, and 4 team leaders. However, the number of final interviewees was reduced to 10 because 2 students with low participation declined to be interviewed. The participants' responses were analyzed to investigate the strengths, weaknesses, and recommendations for the improvement of the model.

RESEARCH RESULT

Six General Design Principles

Reviewing the relevant literature led to identifying six general design principles for the model.

Provide a blended learning environment

The CPS model emphasizes the balance between divergent and convergent thinking in every step of the process. Lee & Lee (2007) suggested that an online environment is effective for divergent thinking, while a classroom environment is effective for convergent thinking.

This study, however, argued that the convergent thinking could also be effective in an online environment if the appropriate supportive systems were implemented. It is possible to design an online environment where both the divergent and convergent thinking can be exercised, and students can discuss their additional ideas with their team members in a classroom environment.

Make students work on a team project

Cooperative learning is effective for creative thinking. Choe (1998) maintained that a personal relationship is the crucial factor for the creative outcomes. He also mentioned that peers could be a new stimulus for producing the creative outcomes. Jeong (2003) stated that the cooperative learning can enhance not only the interpersonal communications but also the creativity thinking skills.

Provide an authentic task

Creativity courses for the college students should be operated in the relevant field where students usually work (Choe, 1998). In a domain-specific perspective, creativity in some specific fields is considered inconsistent with the ones in other fields. In short, creativity can be relatively independent (Han, 2000). Therefore, creativity courses should offer some authentic tasks that provide students with some opportunities to experience their own fields.

Provide an online support system for creative problem solving

Lee & Lee (2007) suggested an online support system for the divergent thinking, and Lee et al. (2007) identified that an online support system in the CPS process is effective. This study includes designing of the environmental supports, not only for the divergent thinking but also for the convergent thinking, and managing the whole processes of CPS.

Provide appropriate guidance for creative problem solving and class management

Since students are not familiar with CPS, appropriate introduction of CPS, creative thinking tools, proper guidance, and feedback should be provided. Also, this principle includes the e-Learning contents and the tutors' supportive roles for students.

Make students write reflective journals

For a teaching creativity, many researchers stated that the internal motivations are the fundamental factors to help produce creativity (Amabile, 1996). While writing journals, students can reflect on their process, and consequently, their internal motivations may be promoted.

Theoretical Components for the Model

Three theoretical components for the model were extracted by categorizing the general design principles. The first is pertinent to the environment where the learning occurs, and it includes the classroom environment and online environment. The second is related to the processes of instructions. There are four phases: a preparatory phase, a preliminary implementing phase, an implementing phase, and an evaluation phase. The last theoretical component would be the process components of CPS. Figure 1 delineates three theoretical components for the instructional model.

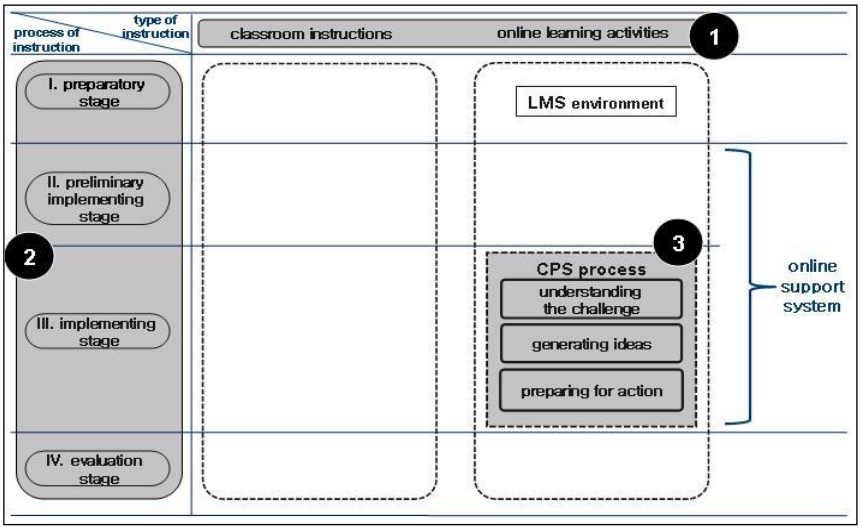

Figure 1. *Three theoretical components for the instructional model*

Specific Design Guidelines

A set of guidelines were suggested from the general design principles and theoretical components. Figure 2 visualizes the specific design guidelines of the integrated instructional model.

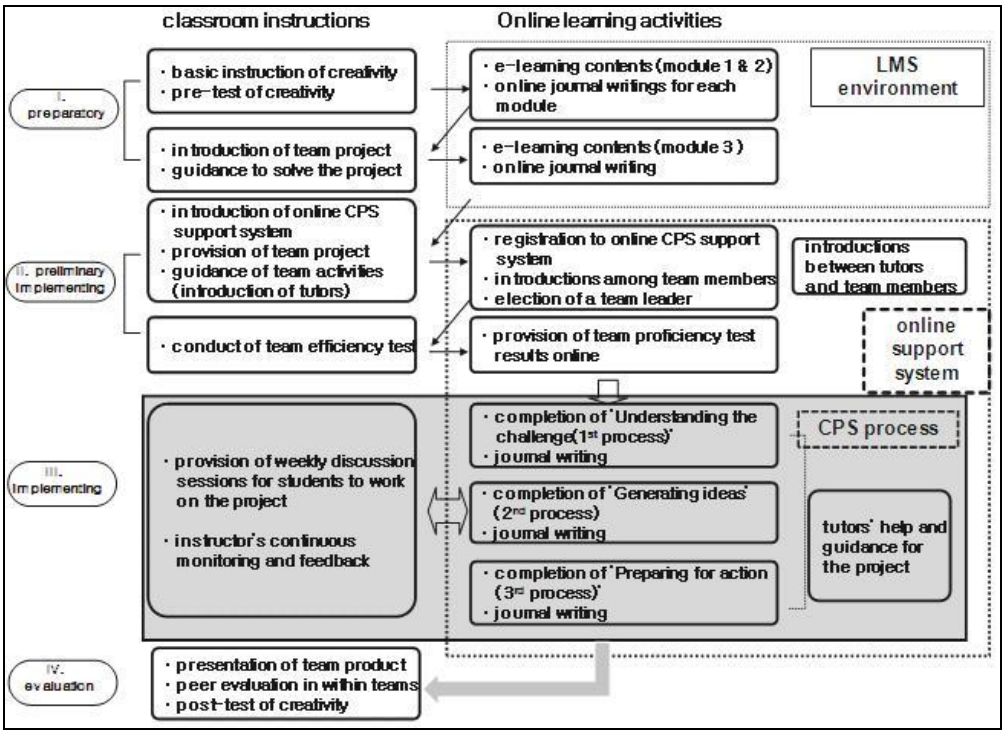

Figure 2. *The integrated instructional model in a collegiate course for CPS with online support system*

In the preparatory phase, the course guidance is introduced by the instructor in the classroom and students learn about creativity through e-Learning. After learning through the contents, students are supposed to write their online reflective journals

In the preliminary implementing phase, the instructor offers the guidance for a project. Students are divided into four teams of seven to eight members each. The students are obligated to register via online support system. After a team efficiency test is administered, the test result is reported to members to guide individual activities for the project.

In the implementing phase, students work on a team project with the direction of their instructor and tutor. In this stage, opportunities for the team discussions and instructor's feedback are offered in the classroom, and students complete each stage of CPS using the convergent and divergent thinking tools embedded in the online support system. Figure 3 shows the processes of CPS.

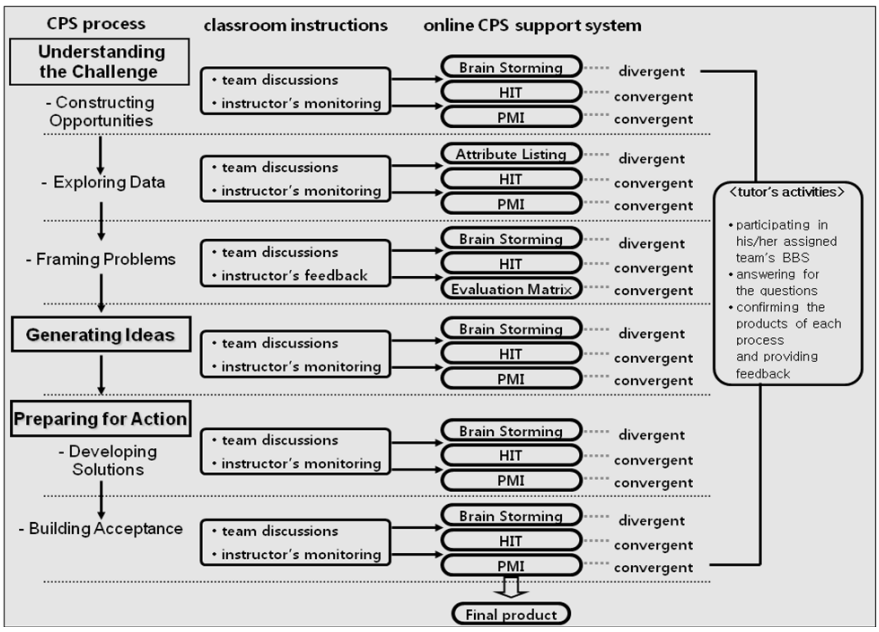

Figure 3. *The integration of classroom instructions and an online support system based on CPS processes*

In the phase 1, 'Understanding the Challenge', there are three stages. In the first stage of 'Constructing Opportunities' students are experiencing the convergent and divergent thinking activities using the online tools, such as brainstorming, attribute listing, hits, PMI, and evaluation matrix. Brainstorming is one of the most popular divergent thinking tools through which students may generate diverse ideas. Attribute listing is one divergent thinking tool that helps a student to list and analyze all the attributes of a problem faced. They finally come up with the alternative solutions by making their thinking deeper and more expanded. 'HITs' is a convergent tool used to reduce the number of proposed ideas. PMI stands for Plus, Minus, and Interesting. It forces students to concentrate solely on one idea and analyze its strength and weakness, along with its interesting aspects. Evaluation matrix helps students to select the most appropriate solution by evaluating the alternative ideas that they generate based on the assigned criteria. In the second stage of 'Exploring Data', students use the attribute listing as well as hits and PMI. In the last stage of 'Framing Problems', brainstorming, hits, and evaluation matrix are provided for students' thinking processes.

In the phase 2, 'Generating Ideas', brainstorming, HITs, and PMI can be used by students, and in the phase 3, 'Preparing for Action', brainstorming, hits, and PMI are offered for the stages of 'Developing Solutions' and 'Building Acceptance'.
Throughout the entire stages, advices of the tutors are available for each team. They can provide the feedbacks on the students' output.

In the evaluation phase, the final output is presented and evaluated, and a peer evaluation for the participation level is conducted.

General Responses to the Model

The interviews were conducted with ten students. Most interviewees responded that the model was effective for solving problem although they also pointed out some weaknesses to be improved. The participants' responses were analyzed to examine the strengths, weaknesses, and improvements of the model.

Selected responses for the strengths are as follows: Utilizing the CPS support system, Implementing a team project, and Providing blended learning environments. Some responses for the weaknesses are as follows: Limitations of the CPS system, Lack of integration between online and offline learning environment, and Improper schedule for the program solving processes. The improvements are as follows: Seamless integration between online and offline environments, Rescheduling the process of the CPS projects, and Providing a variety of thinking tools. Table 1 shows more details for the strengths, weaknesses, and improvements of the model.

Table 1. *Strengths, Weaknesses, and Improvements of the Model*

	Students' responses	Frequency
Strengths	Utilizing the CPS support system	10
	Implementing a team project	9
	Providing the blended learning environments	6
	Providing the tutors' feedback	6
	Providing learning resources in the LMS	3
	Providing the e-learning modules	3
Weaknesses	Limitations of the CPS system; complexness, inflexibility, and the lack of explanation about terminology	10
	Improper schedule for the problem solving processes	10
	Lack of integration between online and offline learning environments	6
	Lack of the tutors' feedback or help for the products of each CPS step and explanations for the new concepts	4
	The number of team members	2
	Improper criteria for evaluating the final products	2
Improvements	Seamless integration between online and offline learning environments	8
	Rescheduling the process of the CPS projects	6
	Providing a variety of thinking tools	3
	Resetting the criteria for evaluating	2

(Number of participants: 10)

Responses of Respective Design Principles

Most interviewees responded that each design principle facilitated the process of creative problem solving. However, some weaknesses and improvements for each design principle existed as well. Students' responses for each design principles are listed in Table 2.

Table 2. *Responses of Respective Design Principles*

Design principles	Students' responses		
	Strengths(Frequency)	Weaknesses (Frequency)	Improvements(Frequency)
Provide a blended learning environment	It was helpful for the process of creative problem solving. (4)	Offline activities were not helpful. (2)	Instructor's instant feedback on the online activities is needed. (1)
Make students work on a team project	Helpful for the process of creative problem solving. (7)		4-5 students are appropriate for one team. (2)
Provide an authentic task	An authentic task for the project was helpful for the process of creative problem solving. (3)		It is needed to provide a task for creative problem solving easy and interest. (1)
Provide an online support system for Creative Problem Solving	CPS system was helpful for the process of creative problem solving. (8)	CPS system rather disturbed the creative thinking. (1)	The improvement in function of each thinking tool is needed. (10)
Provide an appropriate guidance for the Creative Problem Solving and the class management	E-learning contents were helpful for the process of creative problem solving. (10)	There were some difficulties to understand the CPS model in e-learning contents. (7)	The terminologies used in CPS model should be easy to understand. (5)
Make students write reflective journals	Writing reflective journals was helpful. (5)	Writing reflective journals in every step was not helpful. (1)	The numbers of writing reflective journals should be reduced. (2)

(Number of participants: 10)

CONCLUSIONS

Traditional studies on creativity have put more emphasis on the primary and secondary school students' creativity. For creativity education in a collegiate level, 'teaching creativity' as a liberal arts course has been provided(Jeong, 2003; Park, 2004). On the other hand, a study of a 'creativity-integrated course' with a subject matter has been explored as well (Baek et al., 2006). Recent studies about the online support system and the blended learning pertinent to creativity have provided us with some new perspectives on how to teach the creativity skills to college students.

This study focuses on figuring out how creativity would be taught in a collegiate setting. Although researchers have recently paid attention to the significance of creativity, few studies discuss the integrated instructional models in a college level course for the CPS using an online support system. This study identified the general design principles and the specific design guidelines for an integrated instructional model in a college course using CPS with an online support system. The instructional model was developed by the following three steps: discerning the general principles from reviewing the relevant literature; extracting the theoretical components for the model by categorizing the general principles; and finally, developing a set of specific guidelines for each principle based on these theoretical components. The instructional model includes the e-Learning contents and an online support system.

Using the formative research methodology, the strengths, weaknesses, and improvements of the model were analyzed. The strengths included 'Utilizing the CPS support system', 'Implementing a team project', and 'Providing the blended learning environments'. Some weaknesses involved 'Limitations of the CPS system', 'Lack of integration between online and offline learning environment', and' Improper schedule for the program solving processes'. The revised model will include the following improvements:

'Explaining the CPS process in details and providing feedback on students' CPS activities in the classroom', 'Setting an appropriate schedule for the major steps of the CPS, and 'Providing various thinking tools for students to select'.

Through this study, major directions for the improvements of the model were suggested. Further studies are expected in the following areas: to improve the principles and guidelines of the model by using the repetitive formative research methodology and to examine the effect of the instructional model by conducting an empirical study.

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