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The Effects of Motivational Scaffolding on the Learning Process and Outcome in CSCL: Based on the Flow Theory

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This study intends to examine the effects of motivational scaffolding in Computer-Supported Collaborative Learning (CSCL). This study was focused on the following two questions. Do motivational scaffolding lead to positive effects on the process in CSCL? Do motivational scaffolding lead to positive effects on the outcome in CSCL? In order to identify strategies for motivational scaffolding, we reviewed the "Flow Theory." Based on literature reviews, principles and strategies were drawn for the motivational scaffolding. An experimental study was conducted in order to investigate the effects of motivational scaffolding on process and outcome. In this study, 87 undergraduate students were divided into two different groups (control group, experimental group). Motivational scaffolding was provided to experimental group. The process was analyzed by examining learners' satisfaction in process. The outcome was analyzed by examining learners' satisfaction in product, group coherence, and quality of product. The difference between the two groups was statistically significant. From these results, we concluded that motivational scaffolding led to positive effects on process and outcome in CSCL environment.

Keywords : Computer-supported collaborative learning, Flow theory, Motivational scaffolding

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Introduction

Some of recent researches on Computer-Supported Collaborative Learning (CSCL) suggest that there are some problems in designing CSCL because meaningful learning does not occur automatically only because learners are exposed to CSCL environment. Studies in the field of CSCL report that learners are suffering from difficulties in the process of collaboration and they often fail to get collaborative learning (Cohen & Lotan, 1996; Kollar, Fischer, & Hesse, 2006). The related empirical evidences show that the critical influences of learning outcome resulted from the way of learning contents, not from the sophisticate CSCL design factors (Guzdial, Ludovice, Realff, Morley, & Carroll, 2002). According to Dillenbourg (2002), group composition such as size, age and gender, the type of task, and the environment may influence the effectiveness of collaborative learning in CSCL environment. However, each factor influencing collaborative learning itself does not guarantee the learning effect because the complexity of interactions among the factors also affects collaborative learning (Dillenbourg, 2002).

If so, what should be especially considered when we design CSCL? What is the main problem that we should consider in designing CSCL? One of significant questions on CSCL is how we can induce learners to engage in collaboration and meaningful learning. Many studies have attempted to find and explore supporting strategies for collaborative learning (Baker & Lund, 1997; Dillengourg, Baker, Blaye, & O'Malley, 1996). Interactions through activities such as explaining, justifying and evaluating problem solving processes can enhance learning outcome (Baker & Lund, 1997) and well-defined scripts can prompt learners to engage in effective collaborative learning (Dillenbourg, 2002). Dillenbourg and Betrancourt (2006) suggested that conceptualizing epistemic scripts and social scripts might be workable components for improving the environment of collaborative learning. In other words, there is a possibility to enhance collaborative learning through indicating how learners work on a given task and organizing learners' interaction with each other

(Dillenbourg & Betrancourt, 2006).

Among the strategies for supporting collaborative learning, motivational scaffolding is a viable instructional strategy. However, most of research done in this field has paid relatively less attention to motivational scaffolding (Bromme, Hesse, & Spada, 2005; Jarvela, Hakkinen, Arjava, & Leinonen, 2004). We need to scaffold students not only in the cognitive aspect but also in the motivational aspect. From this line of thought, there is one issue that can be focused on the "flow theory." This theory is a construct that focuses on the level of learners' involvement in learning. The flow theory presented by Csikszentmihalyi (1975) is used as a framework for examining the effects of motivational scaffolding in CSCL. Csikszentmihalyi (1975) defined flow as "holistic sensation that people feel when they act with total involvement" (p. 36). Studies on the "flow theory" focus on optimal conditions and methods for enjoying learning based on learners' needs and interests (Prensky, 2001). With many researches about the flow theory, it can serve as a basis for designing motivational scaffolding (Csikszentmihalyi, 1975). The main purpose of this paper is to investigate the effects of motivational scaffolding in CSCL. The major research questions are as follows:

First, do motivational scaffolding lead to positive effects on the process in CSCL?

Second, do motivational scaffolding lead to positive effects on the outcome in CSCL?

Literature Review

Difficulties in computer supportive collaborative learning

CSCL is relevant to how learners learn together using the assistance of computers. In CSCL environment, collaborative learning means achieving a common goal

through the learners' interaction and sharing of their knowledge with one another (Lipponen, 2002). Therefore, designing CSCL environment that can promote interactions for collaborative knowledge creation is significant because it influences directly the effectiveness of CSCL. Through CSCL environment, learners not only improve collaborative skills regarding how to perform a task together with other team members but also acquire knowledge related to tasks individually (Graham & Misanchuk, 2004).

Some problematic situations such as low-level participation, however, happen in CSCL environment. According to studies in the field of CSCL, learners are suffering from difficulties in the process of collaboration and they often fail in collaborative learning (Cohen & Lotan, 1995; Kollar, Fischer & Hesse, 2006). When we design CSCL, we should consider problems that may happen during the learning process. One of significant questions in CSCL is how we can induce learners to engage in collaboration and meaningful learning. Motivation has a meaningful influence on a learners' attitude and behavior (Rienties, Tempelaar & Van den Bossche, 2009). If learners are not motivated, they may not produce positive outcome effectively through collaborative learning. Many studies have attempted to find and explore supporting strategies for collaborative learning (Baker & Lund, 1997; Dillengourg, Baker, Blaye, & O'Malley, 1996). Although the benefits of motivational learning with others, less is known about strategies for motivating in collaborative learning (Järvelä et al., 2010). Especially, there is a lack of research on examining the effectiveness of motivational approach in CSCL (Moos & Marroquin, 2009). Among the strategies for supporting collaborative learning, motivational scaffolding is an important instructional strategy but most of approaches have utilized cognitive scaffolding. In other words, most of research done in this field has paid relatively less attention to motivational scaffolding (Bromme, Hesse, & Spada, 2005). We need to scaffold students not only in the cognitive aspect but also in the motivational aspect.

Flow and learning

The flow theory presented by Csikszentmihalyi (1975) is used as a framework for facilitating learners' optimal experience. When learners fully engage in learning, they experience flow and it influences learners' positive outcome. Csikszentmihalyi (1975) defined flow as a state that individual learners engage in optimal experiences that balance between the individuals' skills and challenges. In addition, flow is referred to as the state of complete engagement in an activity and as optimal experience (Csikszentmihalyi, 1991). If there is balance between skills and challenges, learners can experience flow.

Some researchers examined the relationship between learning and elements influencing learners' flow experience. Craig, Graesser, Sullins, and Gholson (2004) assumed that six different affective states probably occur in the learning process: frustration, boredom, flow, confusion, eureka, and neutral. Through the experiment, they found that learning is correlated negatively with boredom and positively with flow as in Csikszentmihalyi's analysis. Therefore, it is claimed that optimal experience facilitates effective learning, and boredom reduces the effect of positive learning outcome. Previous studies on flow have found that flow experience leads to increased learning (Skadberg & Kimmel, 2004), exploratory attitude (Webster, Trevino, & Ryan, 1993), concentration on tasks, and perceived behavioral control. When learners experience flow, they may feel the pleasure of learning, satisfaction and sense of achievement in terms of positive aspects of flow.

Figure 1. The stages and effects of flow

Figure 1 shows the stages and effects of flow. In learners, flow facilitates increasing learning, exploratory attitude, pleasure of learning, and satisfaction of achievement.

As discussed above, flow experience encourages learners to engage in learning. However, there are some negative consequences of flow (Hoffman & Novak, 1996). According to flow researchers, learners' playfulness may cause longer time in the process of completing tasks (Webster et al., 1993). In addition, over-involvement is likely to cause extra mental and physical efforts and to result in learners' fatigue during the process of learning (Csikszentmihalyi, 1975). All these things support the idea that instructors should consider the negative aspects of flow experience such as longer time, and mental and physical fatigue. Therefore, instructors should design their instruction to reduce such negative aspects when they provide learners with motivational scaffolding based on the flow theory.

Encouraging students' optimal experience in the process of learning can be effective in enhancing learning. Therefore, it is very important to consider strategies to encourage learners' involvement, especially in teaching and learning situations like CSCL where learners' active participation is important. So far there have been few studies, however, regarding strategies for inducing learners' involvement and demonstrating the effects of strategies for inducing flow in terms of motivational scaffolding because most of approaches have been about cognitive scaffolding. In this regard, this study will draw motivational scaffolding strategies based on preceding factors that lead to involvement in CSCL and examine empirically the effect of the strategies.

The antecedents of flow and the implementation of flow antecedents in CSCL

We need to focus on the antecedents of flow, which can be suggestive for deriving design disciplines in developing motivational scaffolding. Flow researchers have used the following components as the antecedents of flow: focused attention (Hoffman & Novak, 1996); perception of challenges that are matched to the person's skills (Chen, Wigand, & Nilan, 1999); a clear set of goals; immediate and appropriate feedback (Chen et al., 1999); and speed and ease of use (Skadberg & Kimmel, 2004). Skadberg and Kimmel (2004) suggested that "improving the quality of flow's

contributors attractiveness and interactivity, and their precedents speed and ease of use can facilitate flow experience" (p. 418). Thus, the antecedents of flow affect the level of flow experience and learning outcome.

So far, there are only a few studies about how the principle of inducing involvement has been applied to learning environment. Kiili (2005) researched digital game-based learning towards an experiential gaming model. According to Kiili (2005), researchers can use the flow theory to facilitate positive user experiences because they assume that the flow theory facilitates the effectiveness of educational games. Craig, Graesser, Sullins, Berry, Gholson (2004) studied the relationship between different antecedents of flow using AutoTutor that is an intelligent tutoring system. They found that there were a positive relationship between learning and confusion, and a negative relationship between learning and boredom. Their study contributed to the theoretical re-conceptualization of flow antecedents. However, previous studies cannot guide instructors on how to induce involvement because those studies were conducted in special learning environments based on high technology such as game learning and intelligent tutoring system. Therefore, this study focuses on strategies for the inducement of involvement applicable to the use of general web boards and web-communities. We applied motivational scaffolding to CSCL environment to find out how motivational scaffolding affects the learning process and outcome in CSCL.

Methods

Participants

We conducted an experimental study that examines the effectiveness of the motivational scaffolding in CSCL. Participants were 87 undergraduate students of 'H' University enrolling the class of 'Methodology for Industrial Education'. The students were randomly grouped in 29 dyads by 3 or 4, and they learned how to design an instructional program for 4 weeks. We placed participants in one of two groups

(experimental group: 18 dyads, control group: 10 dyads). Difference between groups in prior knowledge was not statistically significant.

Research procedure

The experimental study was conducted for 4-weeks. In the 1st week, learners had the opportunity for orientation and team-building training for supporting their collaborative activities. And they received the material that explaining the task through the CSCL environment. In the 2nd and 3rd week, learners shared task-related information that they gathered individually, and discussed about the product for task through the CSCL environment. In the 4th week, learners presented their final products. After the presentation a survey for identification the effectiveness of motivational scaffolding was conducted.

Data collection and coding

A 5-point Likert scale on satisfaction in the process (Jonassen & Kwon, 2001) and group coherence (Price & Mueller, 1986) was used in order to identify the effects of motivational scaffolding. Crombach Alpha for the items was .86. At the end of the survey, an open-ended question was provided for comments on motivational scaffolding. Qualities of learners' products were evaluated by three subject matter experts according to rubric.

Design of Motivational scaffolding

The purpose of this study is to examine the effects of motivational scaffolding for CSCL. Design principles we derived for motivational scaffolding based on flow theory are as follows: 1) to use elements that draw learners' interest; 2) to understand learners' level and provide adapted assignments to them by analyzing the achievement

level and process; 3) to facilitate learners to participate in learning by establishing a clear goal; 4) to provide learners with just-in-time feedbacks based on the analysis of their learning process and achievement level; and 5) to design and develop an efficient interface in order to help learners concentrate on assignments. Each antecedent is used in this study to find the effects of motivational scaffolding. Though we assigned the same task to both groups, each group was under the different experimental setting.

For example, we assigned the control group a task in the form of text but we assigned the experimental group the same task in the form of video that included exciting and authentic problem situations. We had the experimental group try to find out the intention of the content shown in the video (Figure 2).

Figure 2. Snapshot of video for the experimental group

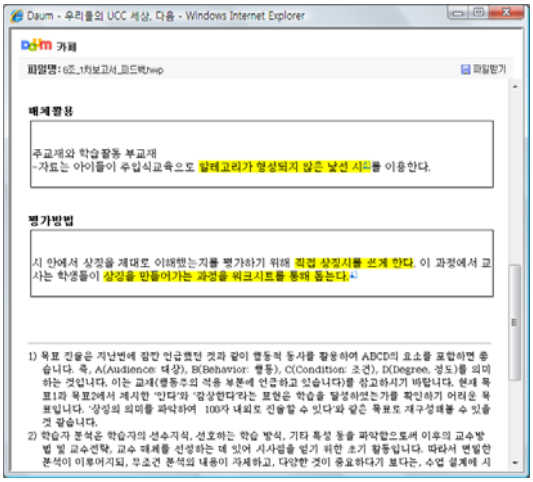

Figure 3. Snapshot of the instructor's feedback for the experimental group

In addition, we provided different supports to the experimental group and the control group. We uploaded learning tips that are helpful in the process of problem solving for the control group but we reviewed the progress of each team's work and gave each team feedbacks for the experimental group (Figure 3).

Especially each group was provided different types of learning environment. The menus and functions of learning environment for the experimental group and the control group are such as figure 4, figure 5.

Figure 4. Snapshot of the Experimental Group's learning environment

Figure 5. Snapshot of the Control Group's learning environment

For both groups, we excluded unnecessary menus for problem solving from learning environment to avoid extraneous cognitive load. The table 1 shows the different setting between 2 groups.

Table 1. Design framework of motivational scaffolding for CSCL

Related Antecedents	Design principles	Control group	Experimental group
Focused attention	Induce learners to have an interest, and to give an attention to learning	Provide material about task by textual forms	Provide learners with tasks involving video and various materials as practical and interesting forms
Perception of challenges that are matched to the person's skills	Provide customized tasks according to learner's achievement level and process	Present simple task	Present customized task in view of learners' prior knowledge
A clear set of goals	Prompt learners to engage learning by setting clear goals	Just provide the task through the CSCL environment	Have learners write the team's goal and problem-solving strategies by themselves and confirm them in the CSCL environment
Immediate and appropriate feedback	Provide optimal, instructional and just-in-time feedback based on learners' own learning process and achievement level	Give the instructor's tips	Have learners submit weekly progress products and give the instructor's feedbacks
Speed and ease of use	Design and develop an efficient interface in order to help learners concentrate on assignments	Minimize elements that cause the extrinsic cognitive load and optimize the learning environment for students to concentrate on their task	

Results

The main purpose of this paper is to investigate the effects of motivational scaffolding in CSCL on process and outcome. According to this experimental study, the effects of motivational scaffolding for CSCL were as follows.

Table 2. *t*-test results of the effects of motivational scaffolding for CSCL

			n	M	SD	*t*
Effects on process	Satisfaction in process	EG	31	3.99	.53	2.24*
		CG	35	3.67	.62	
	Satisfaction in product	EG	31	4.56	.48	3.11**
		CG	35	4.14	.59	
Effects on outcome	Group coherence	EG	31	4.56	.54	2.59*
		CG	35	4.15	.72	
	Quality of product	EG	31	86.22	5.12	3.23**
		CG	35	81.72	6.04	

**p<.01, *p<.05

Table 2 presents that motivational scaffolding resulted in significantly better effects on the process and the outcome in CSCL than did the instructional scaffolding.

The results of the effects on process

As the results of the analysis of effects on satisfaction with the learning process, the experimental group provided with motivational scaffolding (M=3.99, SD=.53) was .32 higher in satisfaction on the average than the control group (M=3.67, SD=.62), and the difference was statistically significant.

The results of the effects on learning outcome

The results of the analysis of effects on learning outcome showed that the motivational scaffolding group was .43 higher in satisfaction of learning, .41 higher in group coherence, and .45 higher in performance outcome and the differences were statistically significant($t(64)=2.24$, $p=.03$). As for satisfaction in product, there were significantly differences ($t(64)=3.11$, $p=.00$) between the motivational group (M=4.56, SD=.48) and the other group (M=4.14, SD=.59). As for group coherence, there were significantly differences (t(64)=2.59) between the motivational group (M=4.56, SD=.54) and the other group (M=4.15, SD=.72). Finally, as for quality of product, there were significantly differences (t(64)=3.23) between the motivational group (M=86.22, SD=5.12) and the other group (M=81.72, SD=6.04).

The results of the open-ended question

The results of the open-ended question about motivational scaffolding were as follows.

First, presenting methods of the task influenced the learners' flow experiences. Learners' responded indicated that fun elements such as the parody of movies led them to be involved in the collaborative activities. The authenticity of the assigned task made the learners engage in flow experiences and the learners paid attention to collaborative activities in case the task was presented in the form of video or animation.

Second, students often tended to make sure during the learning process that they understood their task correctly, their collaborative learning process was effective, and their learning product would be successful. For this reason, students were satisfied with the timely provided feedbacks from the instructor and these encouraged their active participation and meaningful collaborative learning.

Third, students could enjoy the process of collaboration through getting help from

other students and contributing to the team with their own expertise in the process of collaboration. In this process, proper collaboration could be achieved because we supported the students for division of roles among the team members in advance so that they were structured for team tasks. Students had opportunities to understand one another's personal preference and expertise and also had chances to make teamwork and build a common understanding related to team tasks.

Meanwhile, these aspects influenced the team poor in collaborative activities because they interrupted the learners' involvement in case the team members could not coordinate or intermediate various opinions or share roles effectively. As a result, factors such as coordination of opinions among the team members and division of roles played very important roles in collaborative learning.

Conclusions

Researchers who studied flow theory showed that flow experience leads increased concentration on tasks, and meaningful learning (Skadberg & Kimmel, 2004; Webster, Trevino, & Ryan, 1993). In this study, motivational scaffolding was provided to induce the learners' participations and enhance their learning outcome. According to the results of survey, learners were satisfied with the provided motivational scaffolding such as complex and authentic tasks, the methods of presenting tasks, and the instructor's timely provided feedback, and these motivational scaffolding led to positive effects on the learners' flow in CSCL environment. The results of experimental study show that motivational scaffolding influenced the learners' satisfaction with the learning process and learning product. In addition, it was found that motivational scaffolding affected group cohesion and quality of product as well. From these results, it was concluded that motivational scaffolding lead to positive effects on learning process and outcome. In other words, the characteristics of presenting task, ownership, openness, appropriate feedback, and collaboration were

the elements that could influence flow experience. But further study needs to be done to clear that other factors of flow in collaborative learning different from individual learning environment. The model dealing with this issue was not presented in this study. Therefore the research needs more extensive study of a model on this issue.

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