

A Learning Process Mechanism in CSCL

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Abstract: This paper articulates a learning process mechanism in CSCL. For exploration of the learning process, a CSCL program was developed and implemented at a college level course. Fifty-six juniors at a cyber university were required to take the program as a course for eight weeks. Throughout the course, quantitative and qualitative data such as students' perceived learning process mechanism from questionnaires, online messages, interview data, and participatory observation journal were collected and analyzed. As a result, an observable action model and a conceptual model of a learning process mechanism were derived, which students and experts verified. Cognitive achievement factors and satisfaction factors were also considered in the learning process mechanism model. Meaning and implication of each stage in the model were discussed.

Keywords: Learning process mechanism, CSCL, Knowledge building, distance learning

Introduction

Education at a distance is becoming increasingly *interactive* with the ever sophisticated advances in web technology and therefore, interactive discussion learning supported by this technology becomes a more significant field than ever, raising lots of critical issues in research and practice. CSCL(Computer Supported Collaborative Learning) may host many modes of communication, such as threaded discussion forums, chat, email, etc. But threaded discussion is the mode of communication most typically used because of its asynchronous quality which enables everyone to participate at his or her own pace. Most of the research persist positive effects of *interaction* and present various strategies to improve the interaction for better learning (Beuchot & Bullen, 2005; Care, 1996).

Although much of research emphasizes the effectiveness of interaction in CSCL and strategies to make the interaction more active and effective, why and how the interaction or strategies are effective has not yet been studied enough. There is a lack of theoretical research on the learning process mechanisms based on empirical implementation. To find out more effective instructional strategies in interactive distance learning, we need to first understand how the learning process mechanism works in CSCL. Gagné and his fellows also suggest that instructional strategies should be presented in consideration of a learning process (Gagné, Briggs, & Wagger, 1992).

The purpose of this paper, therefore, is to articulate a learning process mechanism in CSCL. This research is concerned with how individuals and groups learn and construct meaning in online discussion boards. This research also considers learning outputs such as cognitive achievement or satisfaction levels for better comprehensive understanding of the learning process mechanism. The learning process mechanism model in this research will contribute an explanation of how students learn through asynchronous collaborative discussion learning.

This research will focus on a learning *process*-oriented approach; such an approach is focused on ‘*where* it makes difference’ rather than ‘*whether* it makes difference’. Many other studies that utilize a learning *product*-oriented approach - such as comparative studies of learning results with the application of certain strategies - showed various differences on their effectiveness. However, it is said to be *no significant difference* by meta-analysis of each research result (Russell, 1999). This ‘*no significant difference phenomena*’ indicates that research needs to shift from trying to *find differences* to *reason the cause of differences*. This research focuses more on *process* than *product*, showing how the learning process is going on rather than what the learning results are, and therefore, presents a more meaningful contribution in the theory and practice of interactive e-learning as the learning process diagram can disclose how social learning process as well as individual one is going in a concrete manner.

Theoretical Background

The learning process has been studied by learning psychologists in behaviorism, cognitivism or constructivism, but learning mainly occurs in our brain so it is basically non-observable. Only the consequences of learning can be observed. So many studies have dealt with the *learning consequences* rather than the *learning process*. But in many cases, these studies generally turn out to be statistically insignificant when one tries to be rigorous about the learning outcome (Russell, 1999). Stahl (2002), therefore, suggests that we should use the term, *knowledge-building* rather than *learning*, especially in regards to collaborative and interactive learning. According to Stahl, *knowledge-building* is more tangible, concrete, and descriptive than *learning*. This term, *knowledge-building*, seems to include whole process of external activity influencing on learning as well as internal learning itself within brain. With care and practice, the *learning process mechanism* can be observed directly and empirically, because it accounts for externally observable activities and artifacts as experiential evidence. So we will use the term *knowledge-building* instead of *learning*, to specify the observable and empirical approach to this research.

One who tried to disclose of the knowledge-building process in Computer-Supported Collaborative Learning (CSCL) was Stahl (2000). Stahl presented a diagram of a knowledge-building process in CSCL by theoretical discussion. His diagram consisted of two circles: one of personal building and the other of social knowledge-building. He explicitly considered the relationship of processes associated with individual minds to those processes considered to be socio-cultural. The significance of his model is that he indicates the importance of social learning, which is considered to be essentially different from individual self-learning. He suggests that knowledge would be shared and constructed by social interaction in a CSCL environment. He is taking a social constructivist’s perspective in which his work impresses upon a sequential process to knowledge-building and provides a starting point for discussing cognitive theory of CSCL as indicated in his research (Stahl, 2000). However, his model was derived from theoretical discussion and it wasn’t verified by empirical evidence. As he mentioned in several papers, the research community need to elaborate upon the knowledge-building process model by utilizing empirical research.

Besides, many studies on modeling the learning process have been reported (Brown, 2001; McIlrath & Huitt, 1995). But most of them use a face-to-face learning environment or do not utilize empirical evidence. Moreover, they present linear learning procedures and do not consider other factors like influential relationship between process and product. Therefore, a study on a comprehensive learning process, one which considers the learning output variables such as cognitive achievement and satisfaction levels as a form of empirical evidence, is needed.

Research Method

In order to articulate a learning process mechanism at college level, a CSCL course was developed. Four experts in instructional design practice verified the course program throughout the development process. The subject of the program was ‘Understanding of Distance Education’ and contents detailed for discussion were about social, cultural, technological, institutional issues in distance education. Fifty-six juniors at K Cyber University in Korea, from ages 20 to 50, were required to partake in team discussions assigned in the class for a period of eight weeks. Throughout the course, the students’ perceived learning process mechanism were collected and analyzed from questionnaires, cognitive achievement tests, satisfaction queries, online messages, interviews, and participatory observation data. Various methods of statistical analysis such as correlation analyses, contents analyses, t-tests, frequency analyses, etc. were applied to the data as well. For students’ perceived learning process mechanism, each student was required to describe his/her own learning process mechanism four times during the course. And the average pattern of their process was derived from the coding of students’ answers.

For evaluation reliability, three evaluators graded the process and their responses were correlated (Pearson $r = .84^{**}$). In terms of satisfaction level, a satisfaction measurement tool which was developed and validated by Kim & Ryu(2000), was used after modification (reliability alpha = .93). Average satisfaction of the course was 4.04 on a 5-point Likert scale (5 = definitely satisfied, 1 = not satisfied at all). Ten students were interviewed at the end of course to verify all quantitative data and to provide more detailed information regarding the factors of the learning process mechanism.

This study followed Rubinstein(1975)’s proposed procedure for modeling the learning process mechanism. According to Rubinstein, the modeling procedure is to achieve a simple high level of abstraction. So the procedure needs to be iterative until we get an abstractive pattern. The procedure of this research was designed in considerations of Rubinstein’s perspective, which is shown in Table 1.

Table 1. Research Procedure in this study

The modeling procedure of the Learning Process in this study	Product
Develop a treatment instructional program	CSCL program
→ Implement the program and collect data	→ 4 questionnaires and online message analysis
→ Make first coding of four questionnaires	→ 17 steps of the knowledge-building procedure
→ Make second coding of four questionnaires	→ 11 steps of the knowledge-building procedure
→ Derive a rough pattern of the knowledge-building procedure	→ Visualization of the knowledge-building procedure
→ Analyze learning output variables	→ Student achievement, satisfaction
→ Correlate learning output variables and each stage of the learning process mechanism	→ First visualization of an action model of the learning process mechanism in consideration of learning output variables
→ Implement interview with learners	→ Interview recording data with 10 learners
→ Analyze interview results to verify the model	→ Decoding the recording → contents analysis → 1 st categorization → coding and 2 nd categorization
→ Derive a verified action model of the learning process mechanism	→ Visualization the action model of the learning process mechanism
→ Conceptualize the knowledge-building action process	→ Visualization of the conceptualized learning process mechanism
→ Validate the conceptual model of a learning process mechanism	→ Validation the conceptual model of a learning process mechanism by 5 experts and 10 students
→ Produce the verified conceptual model of the learning process mechanism	→ The verified conceptual model of a learning process mechanism in CSCL

Results and Discussion

1. An Observable Action Model

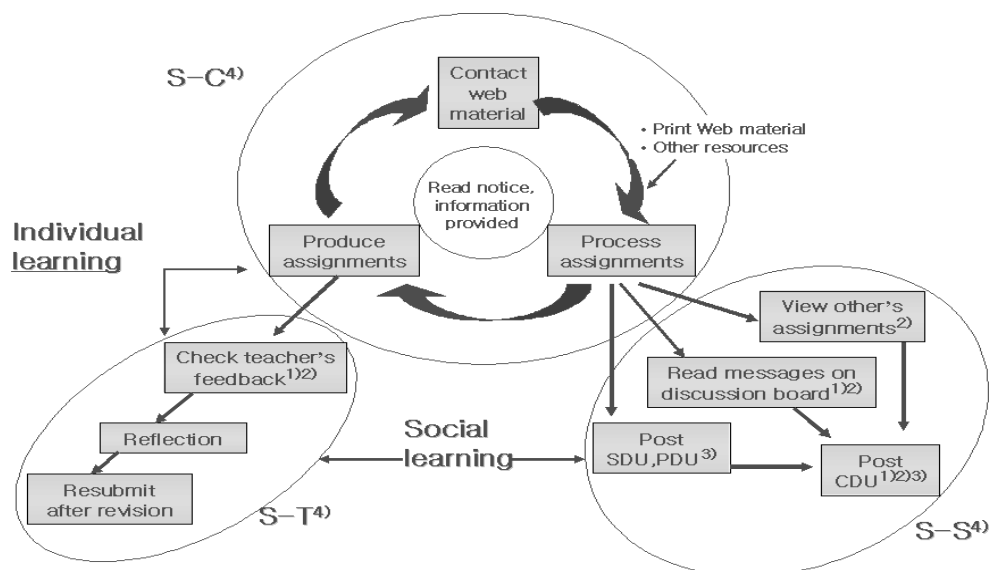


Figure 1. An Observable Action Model of Learning Process in CSCL; 1) Cognitive achievement factor, 2) Satisfaction factor, 3) SDU(Social Discussion Unit), PDU(Procedural Discussion Unit), CDU(Contents Discussion Unit), 4) Interaction types (Students-Contents(S-C), Students-Students(S-S), Students-Teacher(S-T))

To explore a learning process mechanism in CSCL, we coded fifty-six students' perceived learning processes in questionnaires and derived an average pattern of the students' learning process. The students' perceived learning procedure after first coding was composed of 17 stages. Among these items, activities receiving less than 10% frequency of use were removed, and the learning procedure was recoded. All stages were analyzed and correlated with learning output variables such as cognitive achievement testing or satisfaction queries. In addition, all messages on each board were analyzed and categorized by characteristics of message content: SDU(Social Discussion Unit), PDU(Procedural Discussion Unit), and CDU(Contents Discussion Unit), following the classification system of Oren, Mioduser, & Nachmias(2002). A learning process mechanism, in which all stages were rearranged with a logical sequence, was finally derived into an observable action model of the learning process in CSCL(see Figure 1). In the *student-contents interaction (S-C)* circle, students come in *contact with the web material* and then are involved in the *process of doing the assignments*. While students process their assignments, they interact with other students. This kind of action leads to *student-student interaction (S-S)* circle. Meanwhile, when students get feedback from their instructor after submitting their assignments, they check and reflect the teacher's feedback. These steps are for *production of assignments*. This kind of action is categorized as *student-teacher interaction (S-T)*. Throughout this entire process, students *read notices and information* on the bulletin board concurrently. In the *student-student interaction (S-S)* circle, students *view other students' finished assignments*, *read messages on the discussion board* and *post messages(social, procedural, & academic)*. Students were able to see other classmates' finished assignments because all students were supposed to post their assignments to the discussion board for this research. In the *student-teacher interaction (S-T)* circle, after submitting their assignments, students receive and *review the teacher's feedback* on their work. After *reflection*, some students revised their assignments and *resubmit* it. In this model, *reading messages on the discussion board*, *posting CDUs*, and *reviewing the teacher's feedback* are shown as cognitive achievement

clicking through the program, which is far from genuine learning. So this stage of coming in contact with the learning material should be differentiated for articulation.

- **Internal Process:** When learners digest the learning material, an internal process must take effect in their brain, which is not observable but explained by many learning theories. This is for intra-personal communication represented by thought. What's going on in this internal process will not be discussed here because it is beyond this study's scope but it is obviously appropriate to put this step as one of the stages in the learning process model here. If students understand the contents well enough after internal process, they arrive at an individual understanding. Otherwise, they return to the learning material and repeat this cycle until they understand the material.
- **Individual Understanding:** If a learner's cognitive conflicts are resolved through this internal process, students arrive at an individual understanding. Similar to Stahl(2000)'s model, this is distinguished from personal comprehension by internalization. Although we guess that we understand something, we often find that we are unable to explain what we have learned immediately. That is because the knowledge is not fully internalized yet, though it may be slightly understood. Individual understanding therefore could be considered a lower level of comprehension.
- **Individual Externalization:** In asynchronous threaded discussions, students post what they learned from the material after individual-understanding; this action is conceptualized as individual externalization in this research. Students also post messages following socialization or internalization. That is, students express what they learned from social learning or individual learning. So this stage shows two facets: one is a summary of the individual learning phase and the other is the first step to the social learning phase, which also follows the socialization or internalization process. The stage of individual externalization seems to be similar to making personal belief elicited to public statements in Stahl's model(2000).
- **Socialization:** Students participate in discussion by posting messages of what they learned through individual learning or just by socialization. In the social learning phase, students begin to take part in the discussion by posting social messages(SDUs) or asking about procedure(PDUs); this non-academic activity is for their social affinity and rapport. That is conceptualized as socialization in this study. This does not always happen. Once students are socialized enough(SDU), they usually skip this stage and go straight to posting CDUs(individual externalization) after final personal comprehension of one thing. In this research, only 16% of the messages were SDUs. They are shown as fine solid arrows rather than bold arrows to represent a minor process. After socialization, students post content-related academic messages(CDUs) on the discussion board, which is expressed as individual externalization as mentioned above.
- **Social Reflection:** When several individual's messages are posted on the board, students argue and criticize others' opinions. That is called social reflection in this research. Stahl(2000) presents this stage as critic and argument of other people's public statements and discussion of alternatives. Social reflection is a corresponding concept to individual reflection; while one is from inter-personal interaction and the other is from intra-personal interaction, both are basically similar activities in regards of learning in a precise and concrete manner.
- **Shared Understanding:** Through social reflection, students obtain consensus on a topic to arrive at shared understanding which is distinguished from individual understanding. This stage implicates that meaning is constructed by social practice as Stahl indicated(2000). Social constructivists assert that meaning is constructed by social interaction until people share a common understanding. Shared understanding can be achieved from interpersonal interaction whereas individual understanding is achieved only from intra-personal activities.

- **Social Externalization:** When one of the team members summarizes his/her cultural artifacts - product of discussion, summary of consensus, like Stahl(2000) mentioned -, this activity is conceptualized as social externalization which is differentiated from individual externalization. While individual externalization consists of activities such as note-taking or summarizing of what students understand individually, social externalization consists of external expression of socially constructed and shared understanding. Usually one of the team members posts his/her summary or conclusion after discussion, while other team members watch and apply corrections to something that is incorrect or missing.
- **Internalization:** Finally students internalize knowledge into their personal comprehension schema. How knowledge is internalized into a personal comprehension schema after social externalization is one of the critical issues. In Stahl's(2003) paper on Meaning and Interpretation, he indicates that meanings in CSCL are necessarily shared and must be interpreted by individuals. That is, learners interpret social artifacts - which are constructed by social interaction - on each individual's own perspective to reach personal comprehension. This is the only stage of intra-personal and non-observable stage in social learning, whereas other stages are mostly inter-personal and observable. Another piece of empirical evidence of this process is that students who only read messages were found not to be inferior to students who write and post messages in terms of cognitive achievement ($p < .05$). In this research, reading messages as well as writing and posting messages was found to be a critical achievement factor and a satisfaction factor. This finding implicates that one can get meaningful learning though he/she doesn't partake in social externalization after obtaining shared understanding; if one is not a team leader who summarizes their discussion, one is hardly able to get an opportunity to externalize what they share from social reflection and just has to watch and read other's externalized messages. In spite of not partaking in social discussion, these students showed high cognitive achievement as much as others who posted social externalization messages. This means that there is some process for those who don't undertake observable externalization. It may be explained that people internalize their shared understanding by interpreting of social artifacts with each individual's own perspective to reach personal comprehension. In regards to satisfaction, there was no significant difference between students who actively participate in social discussion by writing and posting messages and students who only read messages on the board($p < .05$). This implicates that these students who only read messages also get meaningful learning and satisfaction through the dynamic interaction in the web class and there must be a certain stage to go to internalization. One study gives a significant implication in this context. According to Fulford & Zhang (1993), perception of overall interaction was a critical predictor of satisfaction. They suggested that overall dynamics in interaction might have a stronger impact on learners' satisfaction than strict personal participation. That is, vicarious interaction within the class as a whole than overt engagement of each participant may result in greater learner satisfaction. Therefore, reading only could be considered as a meaningful learning activity. We can suggest there could be individual interpretation of social artifacts on one's own perspective to get to personal comprehension, especially for those who participate in discussion by reading only, not posting at all.

In the end, the conceptual model in Figure 2 was verified by five experts in this field and ten students in this research. Respondents used a 5-point Likert scale (5 = fully verified, 1 = no verified), which was developed based on previous literature(Choi, 2002; Rha & Jung, 2001), to rate validity, explicability, usability, generality, and comprehensibility. Average rate of experts was 4.30 and average rate of students was 4.11 out of 5.00.

Significance and Suggestion

The significance of this research is as follows: first, this study provides a conceptual framework in understanding the learning process mechanism in CSCL based on empirical evidence. Personal cognition and social activity might not be able to be separated artificially like the model in this research. Stahl(2000) indicates by citing Hegel, that it is the nature of a relationship of mutually constituting subjects; neither can exist without the other. But this kind of sequential visualization provides a clearer understanding of the learning process mechanism in CSCL. Second, this article provides a beginning to explain a mechanism of certain effectiveness of observable phenomena. For example, the report (Fulford & Zhang, 1993) that vicarious interaction was a significant predictor of learning output could be correlated with the result that reading - as well as writing - messages on the discussion board was an achievement factor and a satisfaction factor. It is possible to explain that people learn sometimes by only reading in discussion learning because people interpret social artifacts from socially shared understanding with an individual's own perspective to get to personal comprehension. Third, several instructional design strategies such as externalization or group dynamics can be recommended. Besides, the learning process mechanism research in a resource-based self-learning environment or in a synchronous interactive learning environment, or their comparative study can be proposed for further study. Research of more cases in various learning contexts, or utilizing various learners' characteristics, will also contribute to elaborate and generalize the model presented in this research and will enrich understanding of the theory and practice in interactive e-learning.

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