Analyzing Learner Behaviors, Conflicting and Facilitating Factors of Online Collaborative Learning using Activity System

Hyungshin Choi, Myunghee Kang, Ewha Womans University
11-1 Daehyun-Dong Seodaemun-Gu, Seoul, Korea
Email: choi_hs@ewha.ac.kr, mhkang@ewha.ac.kr

Abstract: This research examined learner behaviors, conflicting factors, and facilitating factors while students engaged in collaborative work via asynchronous computer-mediated communication (CMC). A total of 995 postings from 4 groups (19 students) in the spring semester (Study 1) and 6 groups (24 students) in the fall semester (Study 2) were analyzed. A coding scheme was generated based on constant comparison using NVivo 2. All the codes were reorganized via activity system and compared between high and low performing groups to see the difference in the patterns of learner behaviors. This study provides implications for online collaborative learning environment design and addresses challenges in using activity system to analyze learner behaviors.

Introduction

As studies provided ample evidence in which collaborative learning results in significantly higher achievement and retention than do competitive and individual learning (Dyer, 1993; Hooper & Hannafin, 1988; Johnson & Johnson, 1996), online learning has been expanded to harvest the benefits of traditional collaborative learning. Online collaborative learning (OCL) is an emerging instructional approach that embraces the characteristics of collaborative learning and computer-mediated communication in networked environments. Students are given opportunities to extend their learning experiences by sharing their new ideas and receiving critical and constructive feedback from community members (Palloff & Pratt, 2005). Also, learning together provides chances for students to improve collaboration and communication skills that are required on the job (Bennett, 2005). Furthermore, teamwork is another generic skill developed in higher education (Candy, Crebert, & O'Leary, 1994).

Despite the promising benefits of OCL, learners experience tensions from mixed feelings of wanting to learn independently and a fear of being isolated from the community. Dirkx and Smith (2005) argued that these tensions are derived from "ambivalence." Learners think that learning is independent and subjective although collaborative learning requires learners to depend on each other and to allow their ideas to be modified by their peers to achieve a common goal. Besides, unlike in traditional learning environments, the instructor's authority is voluntarily undermined and learners are encouraged to plan and carry out group tasks on their own. In this process, learners experience contradictions while they adapt to a changing role and also learn to exercise authority over peers as they make decisions.

Although there have been studies to understand and evaluate OCL, little research has focused on comprehension of learner behaviors with conflicting and facilitating factors that emerged during group work. In an attempt to understand the phenomenon of collaboration in educational contexts, this study incorporated activity systems analysis. The purpose of this study was to address the following questions:

- Is there any pattern of learner behaviors during online collaborative learning?
- What are the different patterns of conflicting and facilitating factors in online collaborative learning?
- Could the patterns of learner behaviors, conflicting factors, and facilitating factors be aligned in the activity system?
- Is there any difference between the high and low performing groups in learner behaviors, conflicting factors and facilitating factors?

Theoretical Background

Activity theory is a multi-disciplinary framework and it has been used as a socio-cultural analysis framework in social contexts with humans and mediators (Engestrőm, 1987, 1993; Leont'ev, 1978; Nardi, 1996). Activity theory has evolved to reach the third generation. The first generation of activity theory stems from the idea of mediation by Vygotsky. He theorized that individuals actively construct their understanding of the environment while engaging in goal-oriented activities (Yamagata-Lynch, 2003). The second generation of activity theory was derived from Leont'ev's work. He made distinctions among automatic operation, individual

action, and collective activity. In other words, an activity can be divided into several actions by its level and an action can be further divided into operations (Leont'ev, 1978).

The third generation of activity theory has expanded to include the activity system by Engestrőm (1987). An activity system has six interacting components: subjects, objects, tools, rules, community, and division of labor. These components interact with each other to transform the object of the activity system. In doing so, an activity system reveals four subsystems (production, exchange, distribution, and consumption) that describe functions, interactions, and relationships between the six components (Engestrőm, 1987; Jonassen, 2000).

The production subsystem explains how subjects transform the object of the activity system into the outcome. The production subsystem consists of subjects, the object of the activity, and the tools that are used in the activity. The exchange subsystem shows how subjects are constrained by rules and interact with the community in accordance with rules. It consists of subjects, rules, and the community. Rules reflect personal needs, social conventions, or cultural norms within the community. In the exchange subsystem, these rules are negotiated by community members and govern the activity system as subjects achieve a common goal. The distribution subsystem describes how the community defines a division of labor for the subject to accomplish the object of the activity system. The distribution subsystem involves the community, a division of labor, and the object of the activity system. Social laws and expectations affect the division of activities among members of the community. Lastly, the consumption subsystem shows how the subject and the community around the subject collaborate to accomplish the object of the activity system. The consumption subsystem involves subjects, the object of the activity, and the community to which the subjects belong. The subject operates within the community and the community also consumes effort from the subject (Engestrőm, 1987; Jonassen, 2000).

Method

Participants and Context

Data were collected over two semesters in a university setting as two independent studies. Participants included 4 groups (19 students) in the first semester. Two groups were selected from the top performing groups and the other two from the bottom two performing groups. The data collected for Study 1 included 451 messages posted on each team's online discussion board, and documents and products the participants produced related to the group project. The performance was based on the instructor's evaluation of the group project. The group project accounted for 50% of the grade. Among them 30% was a team score which was given equally to all team members and the other 20% was given individually depending on each person's participation.

In order to see the results in a different learning context, 6 groups (24 students) from another class in the second semester were selected for Study 2. Likewise, three groups were from the top performing groups and the other three were from the low performing groups. 544 online transcripts, documents and outcomes produced were collected. Throughout the course, the researcher (first author) monitored all the interactions including instructor's notices and the general bulletin board, and observed the team project presentations in person in order to gain an understanding of the learning context. The reflective semi-structured interviews were sent to 24 participants in Study 2 via emails and seven of them responded to the interviews.

Analysis Procedure

Data were analyzed in two different layers. First, grounded theory was used to generate a coding scheme and to identify emerging themes in learner behaviors, conflicting factors, and facilitating factors. Conflicting factors are defined as contradictions or tensions among the components of an activity system that arise when the conditions of components cause the subject to encounter contradictory situations that obstruct the achievement of the learning objective. Facilitating factors are the elements that learners recognize as positive or supportive to attain the learning objective. The researcher worked with a second coder on sample data and discussed the definitions of each code to reach a consensus. The qualitative tool, NVivo 2 was incorporated to code an enormous amount of data consistently. The frequency of incidents was compared between both studies and high and low performing groups.

Second, the identified codes from the first step were restructured by using activity systems analysis. By the definition of each subsystem, each code of learner behaviors was assigned to one of four subsystems (production, exchange, distribution, and consumption). For conflicting factors and facilitating factors, each code was placed between the relevant components (subject, tools, object, rules, community, division of labor) of the activity system triangle. The frequency of incidents was compared between both studies and high and low performing groups.

Results

Learner Behaviors

The analysis revealed different learner behaviors in the four subsystems of the activity system (see Table 1). Among the four subsystems in the activity system, the consumption subsystem had eleven different

learner behaviors (i.e., share material, suggest an idea, request feedback, ask questions, etc.). The exchange subsystem also had eight different behaviors (i.e., suggest a rule, remind of schedule, evaluate self or peer work, etc.) and the production subsystem showed seven different behaviors (i.e., summarize material, outline tasks, modify material, submit a report, write meeting minutes, etc.). Lastly, the distribution subsystem showed three types of behavior.

Table 1: Learner Behaviors within Activity System (Study 1 & 2 combined).

Activity Subsystems	Learner Behaviors	Activity Subsystems	Learner Behaviors
Production subsystem	Summarize material Outline tasks Modify material Submit a report Submit a status report Submit a project plan Write meeting minutes	Distribution subsystem	Divide tasks Redistribute tasks Create a table of roles
Exchange Subsystem	Remind of things to watch Suggest a rule Share template Remind of schedule Remind of guidelines Raise an issue Evaluate material Evaluate self or peer work	Consumption subsystem	Share material Share contact info Share personal schedules Suggest an idea Request an idea Collect ideas Ask questions Suggest a meeting Suggest group work Request feedback Request to do work

The study compared the high and low performing groups. Both groups showed similar types of learner behaviors although the high performing groups revealed about 1.5 times more incidents of learner behaviors than the low performing groups. Both high and low performing groups revealed the highest incidents in the consumption subsystem, followed by the production subsystem, exchange subsystem, and distribution subsystem, in that order. This phenomenon was the same in Study 1 and Study 2 (see Figure 1).

Conflicting factors

Learners faced contradictory situations as they proceeded with the group project. Identified conflicting factors were located between the matching components of an activity system. Table 2 shows conflicting factors between each component of an activity system. The last two columns indicate whether the particular factor was found in each study.

The most frequently observed conflicting factors were between subjects and tools components in both studies. This was the same phenomenon in both high and low performing groups. Six conflicting factors were considered to be contradictory situations and they included applying inefficient methods, lack of resources, unfamiliarity with processes or methods, system issues, corrupted or incompatible files, and lack of skills.

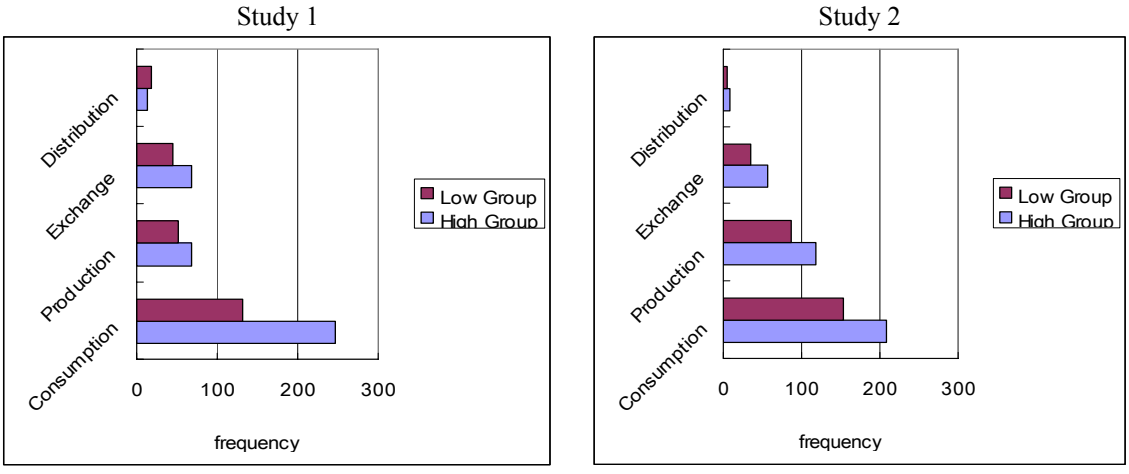

Figure 1. Frequency of subsystems

The next most frequently observed conflicting factors overall were located between subjects and community components in both studies. These factors included uncertainty (difficulty in communication caused by not understanding what other team members meant exactly), nonparticipation, difficulty with relationships (i.e., age and class year differences), conflicts with personal commitments and other subjects/exams, unfamiliarity with team members, and delayed feedback.

Table 2: Conflicting factors between components.

Components	Conflicting factors	Study 1	Study 2
Subject ←→ Tools	Applying inefficient methods	O	O
	Lack of resources	O	O
	Unfamiliarity with processes or methods	O	O
	System issues	O	O
	Corrupted or incompatible files	O	O
	Lack of skills		O
Subject ←→ Object	Difficulty with finding the relevant information	O	O
	Unfamiliarity with topics or material	O	O
	Sharing unrelated information	O	
Subject ←→ Rules	Lack of group rules	O	O
Subject←→ Community	Uncertainty	O	O
	Nonparticipation	O	O
	Difficulty with relationships(i.e., age and class year differences)	O	O
	Conflicts with personal commitments	O	O
	Conflicts with other subjects/exams	O	O
	Unfamiliarity with team members	O	
	Delayed feedback		O
Subject ←→ Division of Labor	Work delays	O	O
	Team members dropping out	O	
	Varying levels of contribution		O
	Issues of role assignment		O

The conflicting factors found were visualized in the triangle diagrams (see Figure 2). In terms of difference in the high and low performing groups, there were more incidents between subjects and objects than between subjects and community in the high performing groups in Study 1. For example, conflicting schedules among team members due to exams and other assignments was more apparent in the low performing groups whereas difficulty with finding the relevant information was more evident in the high performing groups.

In Study 1, the high and low performing groups revealed the same frequency of conflicting factors. In Study 2, however, twice as many incidents of conflicting factors were found in the high performing groups. The difference resides between subjects and tools components in the activity system.

Facilitating Factors

The research sought to identify facilitating factors that are positive or supportive to attain the goal of the group work. Identified facilitating factors were located between the matching components of an activity system. Table 3 shows facilitating factors between each component of an activity system. The last two columns indicate whether the particular factor appeared in each study.

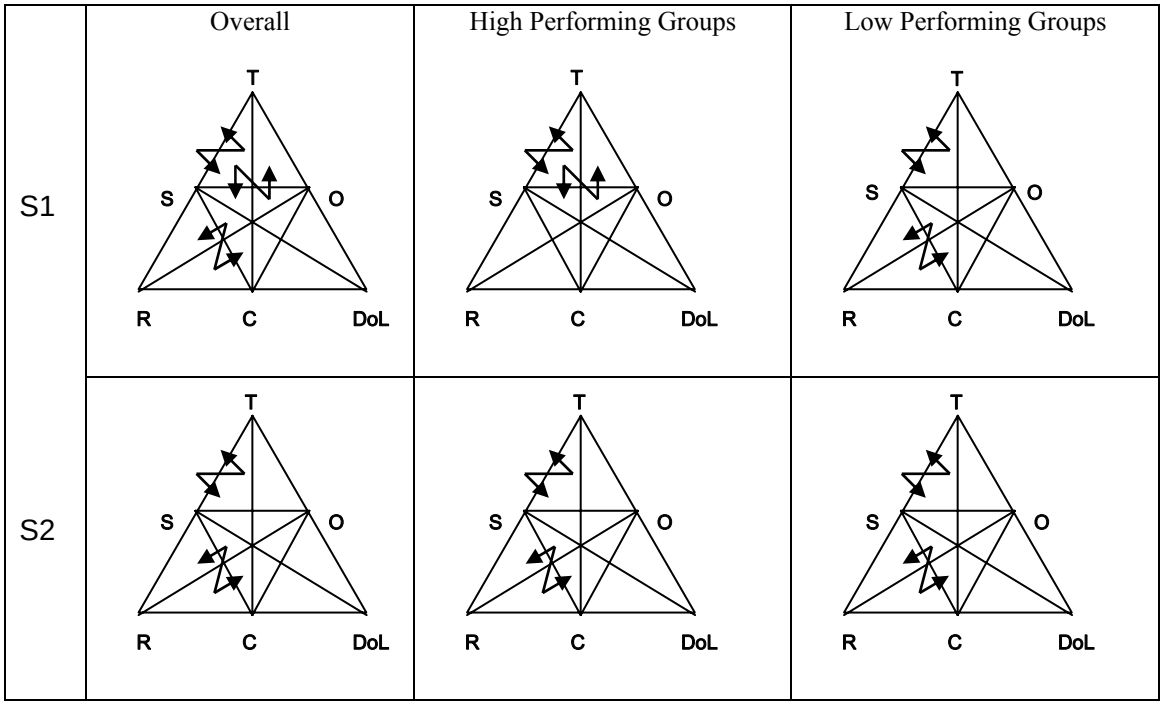

Figure 2. Visualization of conflicting factors in the activity system
(T: Tools, S: Subject, O: Object, R: Rules, C: Community, DoL: Division of Labor, Lighting signal indicates a conflicting factor)

The most frequently observed facilitating factors were found between subjects and community components in both studies. The factors included honesty, proactiveness, responsibility, intimacy, sense of community, encouraging others, trust, and timely decision making. The next most frequently observed conflicting factors overall were located between subjects and tools components. The incidents of facilitating factors between subjects and rules, and subjects and division of labor components were minimal.

Table 3: Facilitating factors between components

Components	**Facilitating Factors**	**Study 1**	**Study 2**
Subject ●—● Tools	Applying efficient methods	O	O
	Competency with tools	O	O
	Previous experience	O	O
Subject ●—● Object	Sense of competition	O	O
	Excellent outcomes	O	O
Subject ●—● Rules	Conforming to rules	O	O
Subject ●—● Community	Honesty	O	O
	Proactiveness	O	O
	Responsibility	O	O
	Intimacy	O	O
	Sense of community	O	O
	Encouraging others	O	O
	Trust	O	
	Timely decision making		O
Subject ●—● Division of Labor	Flexible role assignments	O	O

As shown in Figure 3, a similar pattern was revealed in both studies, and the high and low performing groups. The most frequently observed facilitating factors were found between subjects and community components. The thick bar with rounded ends indicates high incidents whereas the thin bar indicates low incidents. It was noticed that the low performing groups generated a lot more incidents in encouraging others and intimacy factors.

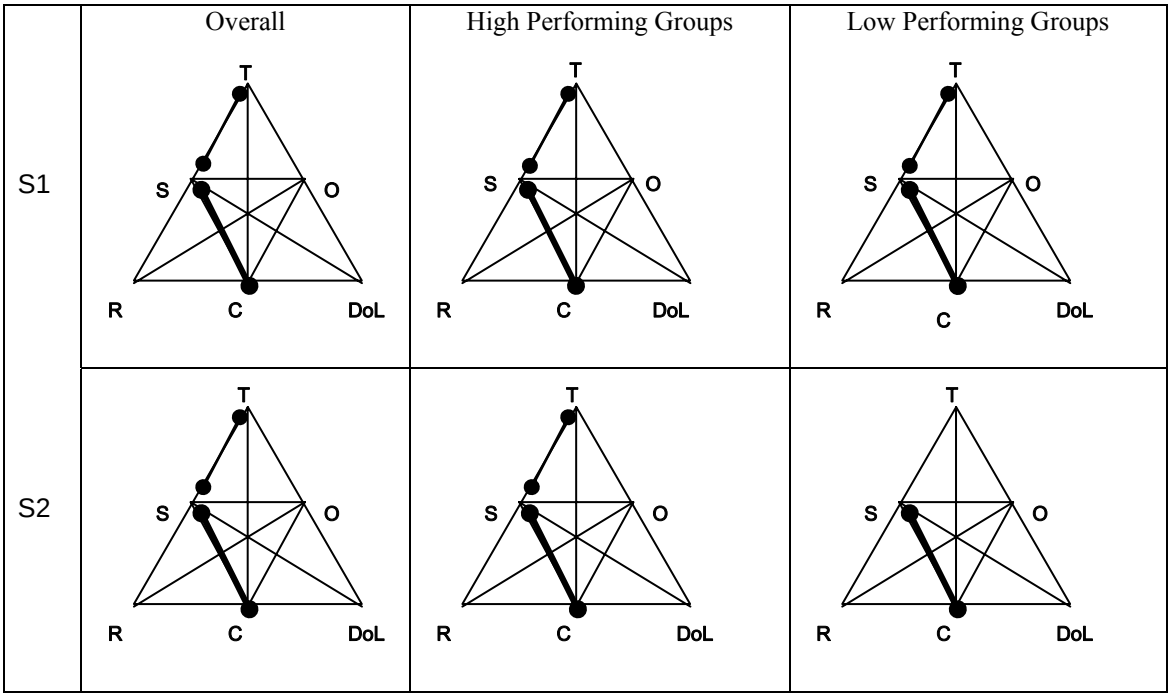

Figure 3. Visualization of facilitating factors in activity system
(T: Tools, S: Subject, O: Object, R: Rules, C: Community, DoL: Division of Labor,
A bar with rounded ends indicates a facilitating factor)

Conclusions and Discussions

The results of this study showed how production, exchange, distribution, and consumption subsystems were activated during collaborative work. Each subsystem can be considered as a learning space in an online learning environment. This study revealed that the consumption subsystem was the most highly activated subsystem throughout the project phases. This finding confirms that the majority of learner behaviors are related to expending the efforts, and utilizing the knowledge, of the community to achieve a common learning goal, and also to produce the required outcomes. Hence, online group work design should be able to support learner behaviors identified in the consumption subsystem. Second, the research findings regarding the conflicting factors implied two different kinds of conflicting factors. One is conflicting factors that aid and stimulate the group process so that team members are more aware of issues in advance. Other kinds of conflicting factors are harmful and could lead to negative learning experiences or poor performance if they are put on hold. Future research is needed regarding specific conflicting factors and how these factors can affect student achievement or the learning process. Third, group cohesiveness was the most frequently observed category of facilitating factors. As the results of this study indicate, facilitating factors such as group cohesiveness are not directly related to group performance. Although Rovai (2002) reported that a sense of community correlates with perceived achievement and persistence, further research on group cohesiveness and actual performance would be beneficial.

From a methodological perspective, this study incorporated activity systems analysis to identify learners' experience during group work**.** According to the definitions of each subsystem, researchers were able to reveal what subsystems were activated during group work and how strongly they were activated. This study provided an opportunity for activity systems analysis to prescribe strategies and to provide insights into the design of a learning environment. As Yamagata-Lynch (2007, p. 480) well summarized, "critics have argued that activity systems analysis complicates research without adding value, oversimplifies human psychology, and does not generate generalizable outcomes." From the experience in using activity systems analysis in the current study, researchers agree that this tool does not provide the detailed levels of analytical procedures that researchers would hope to follow. Hence, there is much room for researchers to add their own theoretical sensitivity and interpretations as they proceed with their research. Perhaps there is a long way to go for activity systems analysis to become a widespread tool and until then, researchers may inevitably share its shortcomings and strengths in educational innovation endeavors.

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Acknowledgments

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