VISUALIZATION MODEL OF GROUP ACTIVITY IN COLLABORATIVE LEARNING

Yasuhisa TAMURA† Daisuke SASAKI†† Sachio KOUNO†

Mariko HIMETA††† Toshio OKAMOTO††††

† Sophia University, Faculty of Science and Engineering, JAPAN
†† Sophia University, Graduate School of Science and Engineering, JAPAN
††† Daito Bunka University, Faculty of Education, JAPAN
†††† The University of Electro-Communications, Graduate School of Information Systems, JAPAN

Abstract

In this paper, a dynamic model of collaborative learning is proposed that represents the interaction between learners and intervention from a mentor at a conversational level. The authors developed the Dual Aspect Progress (DAP) chart which can be used as a two-dimensional graph to visualize the progress of a learner group with regard to cognitive and activity aspects. The DAP chart can also be used to represent intervention from a mentor; e.g., hinting and work direction. Through use of the DAP chart, an observer can identify the learning status and process of a learner group.

Key Words

Collaborative Learning, Learner Group, Conversation, Dynamic Model, Intervention

1. Introduction

Cooperative Learning [1] or Collaborative Learning (CL) [2] is a learning activity based on discussion and cooperative work in a learner group. In recent years, CL has been considered a supplemental learning methodology for conventional classroom and individual learning.

To incorporate CL in real classroom learning, a teacher or a mentor divides all learners into groups of approximately three to five members. Each group is given a task or learning goal and a related deadline. Members of a group discuss and work cooperatively to accomplish the given task or goal. As a result, learners' awareness of the exchanged information and knowledge is promoted during discussion and cooperative work in a group.

CL is expected to enhance learners' ability in a variety of ways. First, metacognitive ability, which includes the ability to monitor the learner group status and discussion process, should be promoted. Second, communication ability is also promoted when one tries to convey an intention to other listeners, or tries to understand other speakers' intention from their utterances. Third, project management ability is promoted through the coordination of conflicting opinions between learners, or the need to lead a group discussion toward a goal. Therefore, many classroom teachers are now trying to apply CL. However, teachers often lack the skill needed to manage CL activity in the classroom because they have little experience in managing CL activity.

Research into CL has taken several approaches based on cognitive or philosophical points of view. For example, Computer-Supported Collaborative Learning (CSCL), using computers and an interconnection network, has been investigated since the mid-1990s. In this research, various models for computer implementation have been proposed. Several international conferences – CSCL95 [3], CSCL99 [4], and CSCL 02 [5] – on CSCL have been held. Also, much of the research presented at an international conference on Artificial Intelligence in Education (AIED) [6] was related to CSCL. Finally, several monographs regarding CSCL have been published in [7] [8] [9]. The initial findings regarding CSCL have been summarized in [3]. In this paper, the CSCL concept is structured, basic components of collaborative learning are extracted, and several reports concerning practical CSCL activities are discussed. In [6], 16 documents concerning collaborative learning are discussed. Distinctive CSCL, Learner Model, Role/Group, Strategy/ Process, and Agent/ Companion elements were extracted in an effort to classify the published research. Also, two proposals for construction of an actual CSCL system have been published in [7]. Kayama et al. proposes that metadata – an abstract description of a target, which includes elements, attributes, and parameters – be used to describe CSCL [10]. This paper focused on a static description of CSCL where the overall model was divided into four parts: learner, teacher, teaching material, and environment.

This paper proposes a CL supporting environment that represents the status of a learner group as an open-ended state transition chart. Although there are many CL entities, such as mentors or materials, we focus on the behavior of a
learner group in this paper. Three axes can be used to describe learners: with respect to the physical granularity, time granularity, and descriptive mode. Physical granularity distinguishes how big (or small) the descriptive target is. For instance, the target may be one learner, one learner group, or several groups. Time granularity focuses on the time scale of description. For CL, the descriptive target may be a single utterance of one learner, a group of utterances made to achieve a given task, or a one-hour class containing various group activities. The descriptive mode can be either static or dynamic in this paper.

Figure 1 shows our target range in this paper. We focus on describing dynamic behavior and analyze how to promote the learning activity for a given task based on the bulk of the learners' utterances. In other words, we attempt to create a model to describe the task accomplishment and the knowledge/skill acquisition of a learner group based on the utterances of individual learners.

![Fig. 1 Target](image)

Few research findings regarding the dynamic process of CL activity, the identification of dynamic group status, or the measurement of achievement for CL dynamics have been reported. Just in [11], there has been proposed a model of the dynamic behavior of a learner group.

The approach in this paper is to describe the proceeding of CL activity visually, to represent the proceeding in a two-dimensional graph rather than a closed-state transition graph. Specifically, we show the cognitive progress on one axis and the working progress on the other axis. In this way, progress in a learner group can be visualized.

One other important characteristic of our proposal is that we visualize the transition of "topic". To accomplish a given task, a learner group typically needs to deal with many related topics in actual CL activities. Group members need to control and decide when and how to hold onto one topic or move to another topic. To visualize topic transition, a monitor or a moderator is needed who is able to understand the group situation.

In this paper, we also discuss the intervention of a mentor, for example, in a learner group. The primary principle of CL is that the learning activity is accomplished through conversation and cooperative work among learners. However, a teacher or a mentor must sometimes intermediate within a learner group to relieve a discussion deadlock or stagnant interaction. Such intervention is outside of the CL principle, but the representation of such intervention makes our proposal more representative of the learning situation in actual classes.

2. Dynamic Model of Collaborative Learning

The dynamic model of collaborative learning (CL) was designed as follows. First, CL activity in an actual classroom was video-recorded. This recording showed the utterances, cooperative work, faces, and gestures of learners in the learner group. It thus clarified the achievement of the learner group with respect to both cognitive and activity aspects. Based on this record, we visualized the CL progress on a two-dimension graph that we call a Dual Aspect Progress (DAP) graph. The DAP graph represents the progress of a learner group with respect to cognitive and activity aspects based on the utterances of learners.

2.1 CL Log Acquisition

We recorded CL activity to clarify the dynamics of collaborative learning at the level of learners' utterance granularity. The target was a French class of Himeta, Daito Bunka University, and the activity was recorded on May 19 and July 14, 2003. The students were divided into five groups of three learners, and three active groups were selected. Three video cameras with remote microphones, wide-conversion lenses, and tripods were used to record the behavior and utterances of these three learner groups. The video-recorded logs for the three groups were transcribed into text. The text log did not note non-verbal expressions (the facial expressions or gestures of each learner), but this non-verbal information was later used to categorize the types of utterance stated below. Figure 2 shows an example.

![Fig. 2 Text Log of Utterances](image)

2.2 CL Dynamic Model

Various models can be developed based on such a log of learners' utterance. In [11], the activity of a learner group was modeled into a finite-state transition graph. The authors
To develop their proposed model, the authors clarified how various kinds of utterance contributed to the progress of the learner group. Based on the utterance log stated in the last section, 17 kinds of utterance were enumerated and categorized.

In this paper, this contribution was assumed to be divided into two aspects: "acquisition of individual and metacognitive knowledge" and "progress of the activity". The cognitive progress and activity progress were analyzed and shown in the proposing DAP chart.

In our experiment, a tentative category was clarified based on the first log acquisition. In the second log acquisition, this tentative category was examined with regard to comprehensiveness and validity. This utterance categories are shown in Fig. 3.

Each utterance of a learner can be thought of as a "state-transition trigger" which leads to progress with regard to the cognitive and/or activity side of the learner group. We expected the utterance category to determine whether progress was made with respect to cognitive or the activity.

Figure 3 shows the result of utterance category and related progress: the upward arrow means the progress of activity, while the right arrow means the progress of cognition. Our results show that each category of utterance leads to progress with regard to both aspects. This result includes some hypotheses, for example the utterance of "proposition" makes progress of activity in the learner group. We should verify it in the future.

Based on the analysis whose results are shown in Fig. 4, we developed the DAP chart to visualize the dynamics of a learner group. The initial state of the group was shown in the lower-left corner of the chart. When one utterance was made in a learner group, it was categorized in the text log. This categorization was done manually. According to this categorization, the target utterance was treated as a trigger of group progress with respect to the cognitive and/or activity aspects. In our DAP chart, the x-axis represents the cognitive aspect and the y-axis represents the working aspect. The initial state of a group changes to another state as shown in Fig. 3. A group of utterances (the connected circle symbols in the DAP chart) are enclosed in blocks to indicate that they refer to the same topic.

Figure 4 shows an example of a DAP chart. In this DAP chart, a small circle expresses the state of the learner group. This state moves to another state (upwards or to the right) because of the utterance of a learner. The direction of movement depends on the category of the utterance as shown in Fig. 3.
3.2 Relation between utterances and learning progress

Our proposed method measures the learning progress enabled through the use of learners' utterances. However, the learners' understanding also might be advanced when the learners remain silent and continue to think. Thus, the problem remains as to how to determine the learning progress not reflected in utterances.

3.3 Descriptive Ability of the DAP chart

As stated, the DAP chart can be used to visualize learning progress. In this chart, advancement with respect to cognition and activity is represented by "Advance" or "Do not advance", much like a digital value. However, the DAP chart does not show the degree of advancement. Moreover, the passage of time is not expressed.

A learner group might become silent or enter a deadlock state. In these states, only time elapses, and the DAP chart does not show these critical states.

For such critical situations, a teacher or mentor should intervene within the learner group. A CL support system should have a function to alert a teacher or mentor when these critical situations occur.

3.4 CL support system with use of the DAP chart

A CL support system using the DAP chart can now be designed. A learner will upload a statement and include information regarding the topic and statement category. The system will generate a DAP chart based on these statements in real time. The system should also have a function to alert the teacher or mentor when a learner group enters an undesirable state of deadlock or silence, or moves away from the target topic.

Such a system may also be able to intervene within a learner group in critical situations by making a statement to encourage the learners to upload a statement or lead the topic in the desired direction.

3. Discussion

3.1 Consideration of the utterance category

In this paper, the learners' utterances were classified into 17 categories. This classification was more detailed and specific than the five categories used in [11]. Recently, Inaba et al. proposes 20 categories based on ontological analysis of CL [12] [13].

However, having too many categories becomes troublesome when a CL support system is actually used in the class activities. For this CL support system, we assume that a learner selects the statement category when uploading a statement. If there are too many categories, though, category selection by learners could become haphazard. The activity of category selection itself might obstruct the uploading of the statement. Category selection might therefore have to be restructured to make it easier when such a CL support system is developed.

In this paper, we have proposed a model for visualizing the dynamics of collaborative learning. This model enables the progress on both the cognitive side and the activity side of the group to be intuitively understood. Intervention by a teacher or a mentor to encourage the learning progress of the group is also represented. In addition, the transition of the topic in the group learning can be intuitively understood. As future work, many varieties of CL activity should be represented with the proposed DAP chart to verify its descriptive capacity and comprehensiveness.

The advancement of CL activity can vary depending on the teacher's skill, the learner's learning ability and
metacognitive skill, and the assumption knowledge of the learners. When these factors affecting CL activity are represented through use of the DAP chart, the capacity, comprehensiveness, and limitations of the DAP chart will be clarified.

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