

A Multivocality Approach to Epistemic Agency in Collaborative Learning

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Abstract: The purpose of this study was to propose a multivocality approach to analyzing shared epistemic agency in collaborative learning and to test its effectiveness by examining actual datasets. We proposed the combination of social network analysis (SNA) and in-depth dialogical analysis as a multivocality approach and analyzed discourse transcriptions of collaborative reading comprehension by university students as datasets. First, we identified pivotal points of discourse where students might engage in an epistemic action toward alleviating a lack of knowledge. Then, we conducted in-depth analysis of discourse segments around the pivotal points. Results revealed that pivotal points identified by SNA were confirmed as alleviating lack of knowledge by further in-depth dialogical analysis. We further succeeded in identifying dialogical patterns in the shared epistemic agency and each individual student's contribution to them.

Keywords: shared epistemic agency, multivocality approach, social network analysis, in-depth dialogical analysis

Introduction

In the learning sciences, and particularly in the knowledge creation metaphor of learning (Paavola & Hakkarainen, 2005), intentional engagement by students in collaborative learning (including collaboration skills and intrinsic motivation) is discussed in terms of epistemic agency. In the metaphor of learning, students are expected to be involved in knowledge creation practice through collaborative construction of knowledge objects (Bereiter, 2002). In creating knowledge in the classroom, Scardamalia (2002) discussed the collective cognitive responsibility of students to contribute their ideas toward collective knowledge advancement. She defines intentional engagement by students in collective knowledge advancement as epistemic agency, and proposes this agency as a new goal of instruction in the knowledge age (Scardamalia, Bransford, Kozma, & Quellmalz, 2012). Based on the previous conceptualization of agency (Bandura, 2001; Emirbayer, & Mische, 1998; Palonen & Hakkarainen, 2000; Scardamalia, 2002; Schwartz & Okita, 2004; Stahl, 2006; Wertsch, Del Rio, & Alvarez, 1995), Damsjö, Kirschner, Andriessen, Erkens, and Sins (2010) further propose shared epistemic agency as a new concept for identifying intentional student engagement in collaboration. Shared epistemic agency is a new layer beyond epistemic agency, comprising individual agency within collective activity, as proposed by Scardamalia (2002). Shared epistemic agency, then, focuses more on the group level of agency in collaboration (Stahl, 2006). Students in collaborative groups engage in the wholly joint epistemic actions of (1) being aware of their lack of knowledge, (2) alleviating this lack of knowledge, (3) creating shared understanding, and (4) generative collaboration. To regulate their joint epistemic actions, students also engage in (1) projection by setting goals and creating joint plans; (2) regulation by monitoring and reflecting on their own advancement; and (3) relation by transcending conflicts, redirecting critical feedback, and creating space for others' contributions. As agency in collaboration is multilayered, students should use both epistemic agency and shared epistemic agency when intentionally engaging in collaborative learning (Damsjö, 2014).

An assessment approach for evaluating multilayered agency by learners has not yet been established. Because the agency in collaborative learning should appear at either the individual (Scardamalia, 2002) or group level (Damsjö, 2014; Damsjö et al., 2010) across different time scales, any single analytic approach would be unable to cover both. We plan to examine a new analytic approach to epistemic agency in collaborative learning from the perspective of the "productive multivocality approach" (Suthers, Lund, Rosé, Teplov, & Law, 2013). The term "multivocality" is derived from a seminal work by Bakhtin (1981) discussing the presence of multiple "voices" in texts. The term refers to multiple voices of researchers who engage in the collective discourse of a field, such as the learning sciences. An assumption of the multivocality approach is that we can advance our knowledge in the learning sciences through the challenge of converting different epistemologies that usually make independent contributions into an interdisciplinary approach that is complementary in an integrative manner. In a book challenging this interdisciplinarity (Suthers et al., 2013), researchers from different

disciplines engage in productive discourse by analyzing shared datasets of social interaction in learning contexts from their own epistemological perspectives and methodologies.

One example dataset provided in this book was discourse among first-year university students engaging in collaborative problem solving in chemistry (Sawyer, Frey, & Brown, 2013a). From the results of an in-depth qualitative analysis, Sawyer, Frey, and Brown (2013b) concluded that two groups (Gillian vs. Matt) differed significantly in their strategic approaches. Based on conversation analysis of the two groups, Sawyer et al. (2013b) described profiles of the two groups. The Gillian group went beyond pure calculation by discussing conceptual ideas about what they had learned and engaged in collaborative knowledge construction through mutual reflection upon ideas. Conversely, the Matt group was involved in calculation activities without articulate recognition of what they had learned. In terms of shared epistemic agency, the Gillian group exerted their shared epistemic agency toward engagement in collective knowledge advancement. We (the first and the second authors in this paper) approached the same discourse dataset using a different methodology: social network analysis (SNA). The original discourse transcription was converted into a bipartite graph of vocabulary and conversation turns, and a temporal social network of vocabulary was constructed. By investigating temporal changes in several network indicators, we quantitatively identified pivotal points of discourse when students engaged in collective knowledge advancement. In addition, we further identified each individual agency by calculating individuals' contributions to the total social network (Oshima, Matsuzawa, Oshima, & Niihara, 2013). The interrelation between in-depth qualitative analysis and SNA was found to be complementary and productive. Both analyses provided unique and replicated findings. SNA demonstrates its analytic power when we are interested in a global view of discourse. We can create graphs of the transition of indicators as a discussion proceeds. After catching the global view of knowledge advancement, we can select several discourse segments to investigate more carefully. In this study, we used dialogical analysis (Wertsch, 1993) and SNA in a complementary and integrative manner to analyze epistemic agency at the individual and group levels.

The purpose of this study was to propose a multivocality approach to analyzing epistemic agency in collaborative learning and demonstrate how the proposed approach would actually function in an integrative manner. The context of learning of interest in this study was collaborative reading comprehension where university students collaboratively read articles to construct their conceptual understanding (a pedagogical approach to the learning environment) through jigsaw-based activities. Discourse transcriptions during the activity were analyzed by an integrative framework of SNA and in-depth dialogical analysis. The integrative analytic approach was focused on an action in shared epistemic agency, and particularly, alleviating a lack of knowledge. Alleviating a lack of knowledge is an important action for students in collaborative reading comprehension because students who read different articles attempt to co-construct their understanding by examining given sources (authors' arguments in the articles), collaboratively collecting new information to understand different authors' arguments, and structuring a new conceptual understanding to integrate arguments from different articles.

Methods

Collaborative reading comprehension was implemented as a part of an intensive course during the summer term of a teacher certification program at a Japanese public university. The course was run for four consecutive days, and the activity was conducted during the first day and a half. The second author was the instructor. Toward fulfilling the course requirements, eight third-year undergraduate students in the engineering department participated in this study. The goal of the course for students was to understand basic concepts of computer-supported collaborative learning (CSCL) in order to appropriately apply lesson plans. The goal for students in the collaborative reading comprehension was to understand basic principles of how to design learning environments (Bransford, Brown, & Cocking, 1999).

Collaborative reading comprehension

Collaborative reading comprehension is an activity structure designed based on the jigsaw method (Aronson & Patnoe, 2011; Brown & Campione, 1996). It encourages learners to engage in collaborative knowledge construction through building an understanding of multiple document resources (Figure 1). Students were first placed in expert groups after listening to an instructor's brief lecture on "the learning environment," which was the target concept. In each expert group, four students collaboratively read and constructed an understanding of one document, which they then explained to others in jigsaw groups. Through expert group collaboration, each student produced a summary by taking notes while listening to an audiobook on an iPod and discussing their ideas based on their notes. After the expert groups finished, jigsaw groups were formed; these groups consisted of one student from each expert group. Students in the jigsaw groups worked to integrate the ideas contained in the four different documents based on the student expert's explanations for each document. After discussing the

four documents, the students reported how ideas from the documents were related to one another and interpreted them with reference to the basic framework of learning environments in the Knowledge Forum CSCL system.

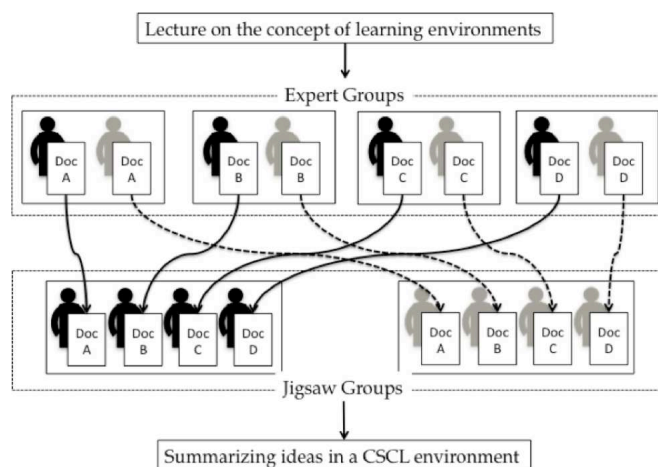


Figure 1. Participatory structure of collaborative reading comprehension

Documents used in the activity came from a book on how people learn in Japanese (Inagaki & Hatano, 1989). We selected four chapters of the book, covering four basic principles of learning environments: learner-centered, knowledge-centered, assessment-centered, and community-centered. Each chapter was transcribed to electronic form and reprinted as a standalone document. These documents were given as listening assignments to the expert groups, and we instructed students to take notes for organizing ideas from their document in relation to the learning environments concept. In jigsaw groups, students brought the ideas summarized from the documents on their note taking and discussed how the ideas from different documents could be integrated for advancing their understanding of the principles of learning environments. To facilitate the knowledge creation process, we further provided students with a whiteboard, on which a large Venn diagram of the learning environment was drawn, as well as sticky notes for inscribing and manipulating their ideas as knowledge objects on the shared space.

Multivocality analysis

As discussed in the previous section, we proposed a multivocality approach to analyze shared epistemic agency in collaborative reading comprehension by shedding light on alleviating a lack of knowledge. All discourse activities in expert and jigsaw groups were video-recorded and transcribed verbatim. We were particularly focused on discourse activities in the jigsaw group. Students engaged in discourse exchange 1,021 times in jigsaw group A and 921 times in jigsaw group B. One reason to pay attention to the jigsaw activity was that students were expected to actively engage in creating new ideas by integrating their knowledge from four different documents.

SNA for identifying pivotal points for alleviating lack of knowledge

For identifying pivotal points in discourse exchange for alleviating lack of knowledge, we conducted SNA by the following procedure. An assumption we held was that we would be able to represent collective knowledge advancement as structural change in a network of vocabulary that students used in their discourse. The vocabulary in this context refers to words used for representing argumentations in the documents students read. The structure of vocabulary refers to meaningful links between words in a sentence or an exchange. When students used words in their exchange, we assumed that they attempted to create meaningful links between words. In other words, we attempted to automatically create concept maps based on students' discourse data (although we could not correctly identify the meaning that students assigned to their links between words).

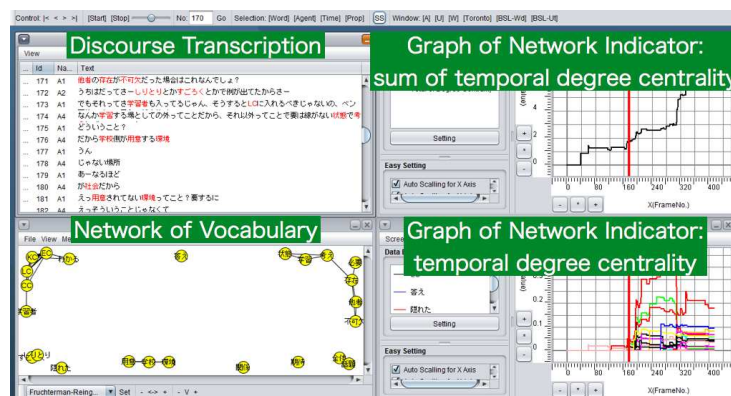


Figure 2. Social network analysis with KBDeX

Based on this assumption, we first created a bipartite graph of words \times exchanges. The first author and a trained graduate student independently detected noun words that they thought represented authors' argumentations in the four documents. We used 305 noun words that both the author and graduate student detected for creating the bipartite graph. Then, we used an application called KBDeX (Oshima, Oshima, & Matsuzawa, 2012) to visualize a temporal network structure of vocabulary and calculate network indicators. KBDeX provides a temporal network visualization and automatically created graphs of network indicators (Figure 2). For identifying pivotal points, we paid attention to the temporal transition of a sum of degree centralities. The degree centrality is a measure of how many nodes are linked to a specific node ranging from 0 to 1. In other words, the degree centrality means how dense a network structure is. When we saw a remarkable increase in the sum of degree centralities of all nodes in a network from one exchange to another, we assumed that the latter exchange contributed to either making an existing network denser or restructuring an existing network by adding new words in such a way that a more robust structure was constructed. Thus, the increase in the sum of degree centralities may indicate that students in a group engaged in more robust ideas related to the original argumentations in the documents, a pivotal point in alleviating a lack of knowledge. In this study, we identified the pivotal points through visually inspecting transition of the sum of degree centrality coefficients and the individuals in a group who were involved in the pivotal points of exchanges.

In-depth dialogical analysis for revealing how students exerted their shared epistemic agency

Our SNA approach was hypothetical in nature and required complementary content analysis. Therefore, we also conducted in-depth dialogical analysis (Bakhtin, 1981; Wertsch, 1993) of discourse segments related to pivotal points identified in SNA. First, we detected sequences of discourse exchanges by tracing discourse back from corresponding pivotal points. Then, we evaluated whether automatically detected pivotal points were related to alleviating a lack of knowledge. Finally, if the sequences of discourse exchanges represented alleviating a lack of knowledge, we further analyzed how individual students in a group dialogically contributed to their shared epistemic agency.

Results

SNA for discourse transcriptions in collaborative reading comprehension

After reading transcriptions of discourse by two jigsaw groups (A and B), the first and third authors held discussions to divide the entire discourse into several discourse scenarios for each group. Here, a scenario refers to sequences of discourse exchanges in which students discussed ideas related to each other. For group A, the total discourse was segmented into three scenarios. Group B was segmented into two. Figures 3 and 4 demonstrate how the sum of degree centralities transitioned in scenarios by groups A and B, respectively. Circled discourse exchanges in each graph were identified as pivotal. By looking at the discourse exchanges around the pivotal points, we found that discourse exchanges identified were pivotal for alleviating a lack of knowledge.

Table 1 shows how many pivotal contributions each student had in discourse scenarios. In group A, student A1 was found to be a key contributor toward alleviating a lack of knowledge. In group B, on the other hand, key contributors in discourse were different across two scenarios. Students B2 and B4 had many contributions in the first scenario, but B1 and B2 had many contributions in the second scenario, when B4 missed the class.

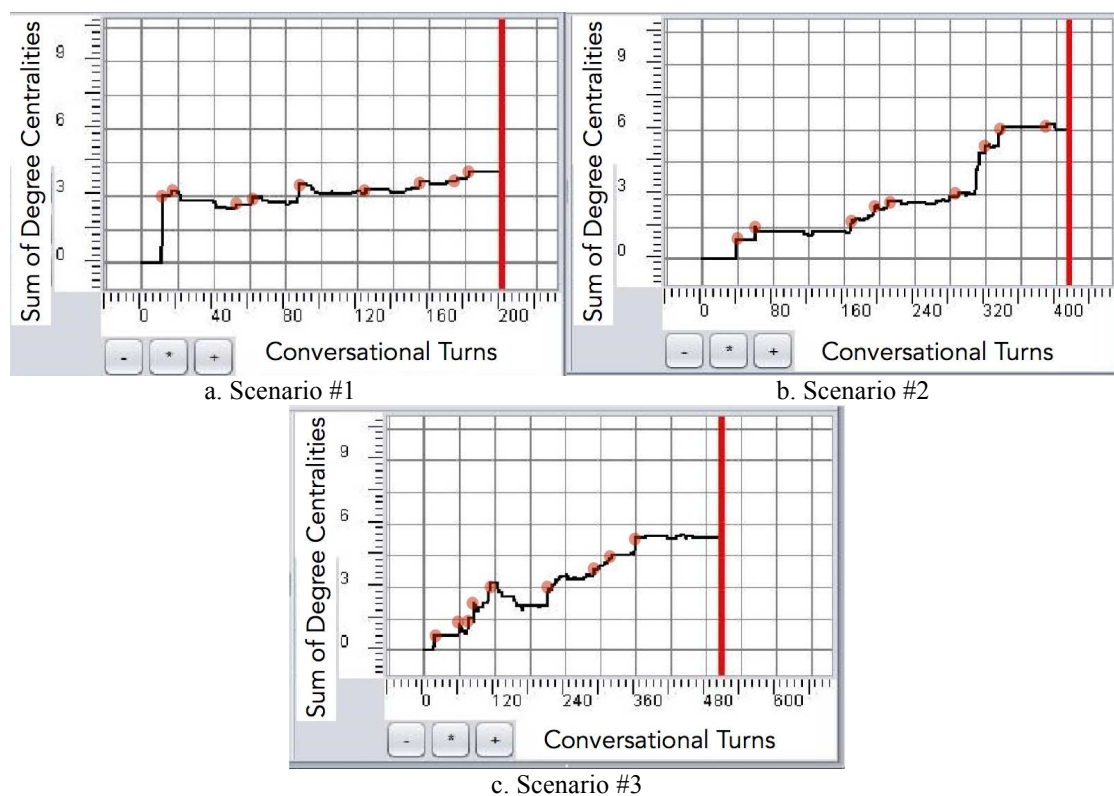


Figure 3. Transitional changes in the sum of degree centralities in discourse scenarios by jigsaw group A

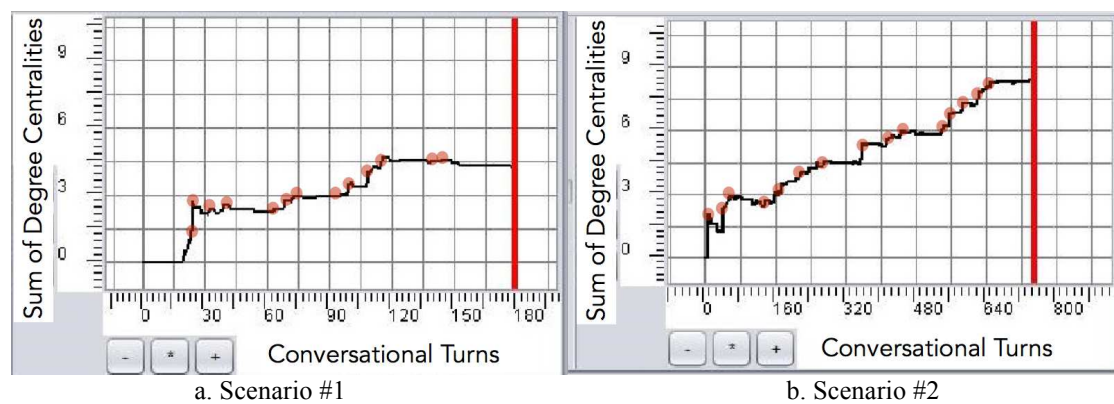


Figure 4. Transitional changes in the sum of degree centralities in discourse scenarios by jigsaw group B

Table 1. Frequencies of pivotal contributions by students

	Jigsaw Group A				Jigsaw Group B	
	Scenario 1	Scenario 2	Scenario 3		Scenario 1	Scenario 2
Student A1	4	7	7	Student B1	1	9
Student A2	4	0	2	Student B2	5	6
Student A3	1	2	0	Student B3	2	0
Student A4	0	0	0	Student B4	5	Absent

In-depth dialogical analysis of sequences of discourse exchanges related to pivotal points

After our SNA of discourse transcriptions, we further conducted in-depth analysis of discourse segments related to the pivotal points. Due to space limitations, we report one segment from each jigsaw group. The following is a segment of discourse from group A regarding the learner-centered design. The original discourse was in Japanese, and we have translated it into English.

- Student A2: It is not easy for learners to conduct intentional learning when their context does not support them. They need tools for engaging in intentional learning. So, we are discussing the context rather than the learners, aren't we?
- Student A1: But it is too simplistic to describe that this is entirely the issue of context because of the existence of tools for students.
- Student A3: We had better not say like "OK, this is an issue of context because of tools."
- Student A1: No, we should not. Yesterday, we discussed that the authors argued for the community-centered design when they described the context including others, tools, and so on because these factors facilitate students to intend to learn.
- Student A3: Yeah, we did.
- Student A1: We should not misunderstand the authors' argument. They did not argue that the context, such as others or tools, determines how students learn. In more precise terms, they argued that the context does facilitate how students intend to learn. These are remarkably different, aren't they?

In the discourse segment, the last discourse exchange by student A1 was identified as pivotal by SNA. In his last discourse exchange, student A1 alleviated a lack of knowledge about the learner-centered design and the community-centered design, and their interrelation as discussed in the documents. In the sequence of discourse exchanges, students A2 and A3 were found to engage in epistemic actions for student A1, who ultimately utilized his turn to facilitate their awareness of the problem (i.e., the first turn by student A2 and the third turn by student A3). In jigsaw group A, dialogues for exerting shared epistemic agency were represented by this example of discourse. Student A1 was responsible for ultimately promoting shared understanding towards alleviating their lack of knowledge, and other students (A2, A3, and A4) started sequences of discourse exchanges by creating awareness.

In jigsaw group B, we also found students' established dialogues for their shared epistemic agency towards alleviating a lack of knowledge. However, the dialogical practice in jigsaw group B was different from that in jigsaw group A.

- Student B4: B3, in what you said.
- Student B3: Yeah.
- Student B4: The authors proposed a variety of ideas related to different sections [in the Venn diagram of learning environment]. But all the ideas are related to the community-centered design.
- Student B3: In chapter 7, I read that the core concept was the community-centered design. All ideas are placed in intersections between the community-centered design and others.
- Student B4: I agree. I first did think that the community-centered design was independent of the three other designs. But, after your idea, I now think that those are overlapped like the Venn diagram. The community-centered design is related to all the others.
- Student B2: I also think so.
- Student B4: Age is also another factor for designing learning environments, I think. Depending the age of learners, we have to put different priority on the four designs. For younger kids, for instance, the knowledge-centered design does not seem to have much priority on designing learning.

In this discourse segment, the last discourse exchange by student B4 was identified as pivotal in SNA. Student B4 was engaged in integrating the other students' ideas to alleviate the preexisting lack of knowledge. The difference in dialogical patterns between the two jigsaw groups was that student B4 was also responsible for the awareness of the group's lack of knowledge. He intended to elicit others' ideas by revoicing others (i.e., the third discourse exchange). Other students (B3 and B2 in this discourse segment) were engaged in epistemic agency to provide additional information and examine B4's argument. This dialogical pattern was frequently seen in jigsaw group B to engage in their shared epistemic agency.

We accidentally found another pattern by group B. On the second day, when student B4 missed a class (scenario #2), other members were engaged in discourse holding different roles. The most remarkable result was that the role of student B1, who had not been active in scenario #1, changed to one of active engagement, identifying and alleviating the group's lack of knowledge by regulating other group members, just as student B4 had done in scenario #1.

Discussion

With discourse transcriptions as data, we conducted a multivocality approach to analyzing students' shared epistemic agency, specifically, toward alleviating a lack of knowledge. As a multivocality approach, we proposed a combination of SNA and in-depth dialogical analysis. In the following, we discuss the potential productivity of this approach.

SNA can be used for numerically identifying pivotal points of the alleviation of a lack of knowledge as well as the creation of awareness. The rapid increase in the sum of degree centrality coefficients of nodes was confirmed as a vital sign for collective knowledge creation. Dialogical analysis of discourse segments around pivotal points in SNA suggested that we could numerically identify how students engaged in the particular actions of shared epistemic agency. However, there might be pivotal points of discourse exchanges that we could not address by SNA. To test this, we must conduct in-depth dialogical analysis for all the transcriptions and compare results between the dialogical analysis and SNA.

We also examined each individual's contribution by counting and comparing numbers of pivotal points by different students. On the contrary to our naive prediction of egalitarian contribution, we found idiosyncratic contribution patterns. Some students made more contributions than others. In group A, one student was mostly responsible for the agency, whereas several students had critical contributions in group B. As discussed in the next paragraph, however, these patterns of social interaction were rather productive practices where students engaged in shared epistemic agency in a variety of ways.

Complementary in-depth dialogical analysis provided us with rich information for clarifying how students engage in their epistemic actions toward alleviating a lack of knowledge. The pattern of each individual's contribution was found to be stable, indicating that students might have their cultural epistemic practices established through their experiences of being together across several courses before taking this course. In group A, students more collaboratively regulated their agency, whereas specific students in jigsaw group B (B4 and B1) were dominant. It was also found that students' epistemic practices were resilient to unpredictable events. Even when a dominant student (B4) was not present, remaining students in jigsaw group B could maintain their epistemic practice through different contribution patterns (student B1, who had been inactive in scenario #1, took over the regulation of the epistemic actions of the group).

Conclusions

In summary, the multivocality approach combining SNA and in-depth dialogical analysis to shared epistemic agency in collaborative learning was found to be productive in that SNA presented a macroscopic view of how students in groups engage in epistemic actions to create their new knowledge. On the other hand, in-depth analysis of discourse segments identified as pivotal by SNA provides a more microscopic view of group cognition (Stahl, 2006). This study dealt with small datasets of just two groups in collaborative reading comprehension. For further testing the reliability of the combination of SNA and in-depth dialogical analysis of shared epistemic agency, we need to conduct future studies (1) to deal with larger-sized datasets and (2) to analyze different epistemic actions.

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Acknowledgments

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