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Designing Collaborative Learning Activity for the Abstract Knowledge Creation

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Abstract: This study demonstrates that collaborative learning for the abstract knowledge creation involves three conditions: (1) the sharing of various representations, (2) the discussion of solutions, and (3) the absence of teacher interventions. We found that when these conditions are embedded in the design of a lesson, students are able to gain knowledge, even if they do not find solutions. Our research design involved two classes of sixth-grade students. In mathematics lessons, a teacher asked students to come up with the number of games of a round-robin football tournament. One classroom used a Jigsaw method and the other did not. One or five months later, students were required to write what they remembered of specific lessons on a retrospective test. Students in the non-Jigsaw classroom included those who retained knowledge and those who did not. However, students in the Jigsaw classroom recalled what they had learned, except for a certain group. Through a dialogue analysis of each group with KBDeX, we found that certain types of discourse were promoted by lesson designs. In the first type, students shared various representations (e.g., concrete scenes, symbols, computations, diagrams or tables) and discussed solutions. In the second type, they pooled single representation and only discussed answers. In the third type, students shared various representations but only discussed answers. In the Jigsaw classrooms, in which most of the first type of group was located, students with different ideas discussed solutions. In contrast, in the non-Jigsaw classrooms, with the first and second types of groups, those with differing ideas did not discuss solutions. In addition, we found that the third type of group did not consider solutions with a teacher's intervention. In order to enhance activities of sharing representations, now we are designing the activities that students use tablet devices.

Keywords: Collaborative learning, abstract knowledge creation, jigsaw methods, retrospective test

1. Introduction

It is clear that knowledge building through collaboration is better than knowledge acquisition through instruction, since the former method allows for the development of adaptive expertise and deep understanding. However, high quality collaborative learning usually depends on the intentions of each student. We must develop lesson designs that effectively promote constructive interaction among students. For example, "knowledge building" represents an attempt to refashion education in a fundamental way, one that introduces students to knowledge creation (Scardamalia and Bereiter, 2006). Brown and Campione (1996) develop a model called "fostering a community of learners" (FCL) for grades one to eight. The FCL project uses the "Jigsaw method" (Aronson, 1978). Students from each of the subtopic groups come together to form a Jigsaw group in order to share their knowledge of these subtopics and to work together on some consequential task. CoREF at the University of Tokyo in Japan has been striving to help teachers develop a network community of learner-centered classrooms with the Jigsaw method (Miyake, 2012). Our design research seeks to determine what activity encourages abstract knowledge creation. However, we employ a new measure because correct interpretation requires correct observation (Pellegrino *et al*., 2006). Schwartz and Martin (2004) focus on adaptive expertise, which has been called "preparation for future learning" (PFL). They developed a new measure called the double transfer assessment of PFL, and we came up with a new measure called the "Retrospective test."

2. A Method of Evaluation

a. Retrospective Test

We carried out the Retrospective test one month or more after the students' lessons. Students were required to describe all that they remembered of a specific lesson on the Retrospective Test. Test items are shown below.

1) With whom did you carry on a discussion?
2) What kind of lesson was it? Please write all that you remember of it.
3) What did you talk and think about?
4) Who talked about what?
5) What did the teacher talk about?
6) What did you learn?

2.2 Dialogue Analysis

We analyzed the patterns of dialogue through the results of the Retrospective test. We recorded the dialogue of each group and analyzed each protocol. The classifications are shown below. If necessary, we used the social network analysis tool called KBDeX (http://www.kbdex.net).

1) What type of a solution did the students explain?
2) Did students discuss how to solve a problem or to answer a question?
3) What was the rate of intervention by the teacher?

3. Design Experiments

a. Non-Jigsaw Classroom: Pre-research

In 2011, we collected data from the non-Jigsaw classroom, which had twenty-three students. First, the teacher asked the students, "What is the number of games of a round-robin football tournament?" In the first half, students solved problems in groups, after tackling them individually. In the second half, they reported their representations and solutions, and then the teacher explained the correct answers and solutions. Table 1 shows the results of each group. Student ideas determined if there were various representations. Therefore, students were divided between those who retained knowledge of the groups' activities and those who did not.

Table 1: Results of non-Jigsaw classroom of 2011.

	Pattern of dialogue			At the end of group activity	Retrospective test (A month later)	
	Sharing of various representations	Discussion of solutions	Interventi on by the teacher	Accept a correct solution or answer	Episodes	How to solve
Group N1	Yes	Yes	13%	No	67%	67%
Group N2	No	No	6%	No	100%	0%
Group N3	No recorded data				100%	50%
Group N4	No recorded data				100%	100%
Group N5	No recorded data				100%	75%
Group N6	No recorded data				75%	75%

b. Jigsaw Classroom: Designed Lesson

In 2012, we designed and practiced a lesson in the Jigsaw classroom, which had twenty-four students. First, the teacher asked the students, "What is the number of games of a round-robin basketball tournament?" In the first half, students solved problems with the selected specific representation (calculations, tree diagrams, object, or pictures) in expert groups, and then they shared each

representation and discussed solution in jigsaw groups. In the second half, they reported their representations and solutions, and the teacher explained the correct answers and solutions. Table 2 shows the results of each Jigsaw group. It indicates that almost all students knew the solutions to problems five months later, but those in half the groups could not write the episodes. Only Group J1 did not arrive at a solution because of intervention by the teacher in a Jigsaw activity. Figure 1 shows the differences in social networks of sharing of various representations between Group J1 and J4 by KBDeX.

Table 2: Results of Jigsaw classroom of 2012.

	Pattern of dialogue			At the end of jigsaw activity	Retrospective test (5 months later)	
	Sharing of various representations	Discussion of solutions	Intervention by the teacher	Accept a correct solution or answer	Episodes	How to solve
Group J1	Yes	No	49%	Yes	100%	50%
Group J2	Yes	Yes	8%	No	50%	100%
Group J3	Yes	Yes	8%	No	33%	100%
Group J4	Yes	Yes	3%	Yes	100%	100%
Group J5	Yes	Yes	6%	Yes	100%	100%
Group J6	Yes	Yes	3%	Yes	25%	100%

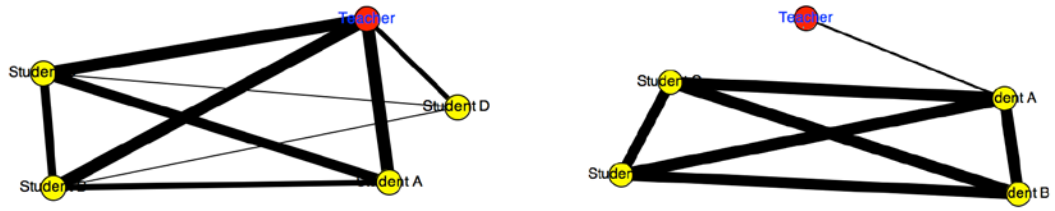

Figure 1. Social networks of sharing of various representations (Left: Group J1, Right: Group J4)

4. Discussion

We found that collaborative learning for abstract knowledge creation requires three conditions: (1) the sharing of various representations, (2) the discussion of solutions, and (3) the absence of teacher interventions. In future, we want to support students' activities of sharing various representations using one-to-one tablet devices in order to enhance the discussion of solutions.

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