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Collaboration as constructive interaction and the jigsaw method as its enhancer

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Abstract. This position paper introduces the theory of "constructive interaction" (Miyake, 1986), claiming that differences between members make a conversational interaction constructive. From this theory, the quality of collaboration depends on how often constructive interactions take place among members and to what degree each member deepens her or his *own* understanding through the interactions. This divergence, individual oriented theory is contrasting to the convergence, group oriented theory (Roschelle, 1992). I will explain that the former is suitable in this knowledge creating society as well as beneficial to clarify fundamental mechanisms of collaboration with some empirical data. In addition, in order to show the benefits of the theory, I compared jigsaw-type collaboration with normal-type one in cognitive science education. As a result, the former outperformed the latter, indicating that the legitimization of differences could promote constructive interactions.

1 Collaboration in the knowledge society

In this knowledge creating society, innovation and creation should be the heart of our knowledge works (ATC21S, 2010). We should take care of not only how to solve present problems in routine ways, but also to identify and solve future problems in creative ways. Aims of the society also change from how to achieve pre-defined goals quickly to how to "go beyond" or *surpass* (Bereiter & Scardamalia, 1993) them deliberately. Collaboration can help this, given that we have adequate theories of collaboration and designs of collaborative environments for this "surpassing ourselves" society. We need theories of collaboration which

illuminate ways to push everyone go beyond her or his own present goal. We also need new designs of learning environments for acquiring such collaborative skills. I will explain theories in the second section and designs in the third one.

2 Theory of constructive interaction

When one tackles with a complex problem and reaches her or his own satisfactory solution, s/he often runs out of resources for checking its validity. Yet, if there is someone who monitors solver's explanation of the solution, the monitor can provide with "criticisms," which leads the solver to rethink it and deepen her or his understanding of the task. This is the virtue of collaboration. Thus, we often experience collaboration as precious but laborious, in the sense that it triggers our reflection upon what we once considered as "solved" or "understood."

The *theory of constructive interaction* (Miyake, 1986; Shirouzu *et al.*, 2002) explains these phenomena best. It claims that differences among members are precious sources for collaboration. Differences make a conversational interaction constructive – constructive in the sense that the members can come to understand what was not understood and find the way toward the fuller accomplishment of what they wanted to accomplish.

The differences come from two ways: *initial diversity* and *role exchange*. The former is members' individual differences in prior experience, knowledge, and expertise brought in the situation. The latter speaks to role exchange between task-doing and monitoring in collaborative situations. When one member engages in task-doing like solving a problem, the other member only can monitor that process. Yet, the monitor cannot fully share the task-doer's internal plans, intentions, or interpretations, and thus observe the process from a slightly broader perspective, which contributes to providing with objective comments or criticism. In successful collaboration, two factors, active externalization of the initial solution and the frequent role exchange, interact to generate various solutions differing in the degree of abstraction (Shirouzu *et al.*, 2002).

This theory implies two keys to the quality of collaboration. First, the quality of collaboration depends on how often constructive interactions take place among members by role exchanging. It does not concern collaboration *products*, but *processes* (Baker, 2010). Second, it depends on to what degree each member deepens her or his own understanding through such collaboration. It concerns products, but *non-predefined products*, because s/he pursues her or his own, idiosyncratic goal. This demands new assessments of collaboration:

- analyzing collaborative processes by backtracking from emergent, finally achieved goals,
- focusing on the reflective and deliberate nature of collaborative thinking, instead of the efficiency of how to get at the one, predefined goal,

- tracing diverse processes of understanding, innovation or whatever of participating members, and
- thinking not only of inter-mental interactions, but also of intra-mental interactions between internal knowledge and external cognitive resources of each member.

These proposals, especially the latter two, take a somewhat individualistic view of collaboration. It contrasts with the "co-construction" view shown clearly by Roschelle's (1992) statement as "a crux of collaboration is convergence to the shared, common understanding." This is the prevailing view among various disciplines like CSCW, CSCL, and learning sciences. So, why do I take the former?

The first reason is changing goals of collaboration in this knowledge society, as written above. The second reason is that, even in the shared problem solving or learning situations, we often observe starting points, intermediate processes, and resultant achievements differing from member to member (Forman & McPhail, 1993; Miyake, 1986). We also often witness a well-designed class wherein many children present many different ideas, which push their conversations to more scientific levels. Although it leads them to seemingly "mutual" understanding, we often find dozens of different explanations or expressions in individual reports or interviews after the class (Hatano & Inagaki, 1991).

Learning processes are so diverse that, as we collect finer-grained data or analyze the same data at finer-grained levels, more individual differences appear. Actually, Miyake (2008) and Shirouzu & Miyake (2002) re-analyzed Roschelle's case (1992), especially expressions used by individual students (Carol and Dana), only to find a different pattern other than what Roschelle had found. Roschelle's analysis, taking the pair as a whole and analyze their language as each complementing the other, made the convergent pattern emerge in the targeted direction. Our analysis, however, taking individuals as its unit, showed that the resultant pattern was lopsided: among the 14 key expressions we selected, only three were shared or frequently used by both. Miyake (2008) stated:

> This pattern indicated that each student had held her own model to the very end of their collaboration, where they could complement each other's explanation. While this complemented whole does represent their "common ground," it does not guarantee a shared understanding. It could even be said that the complementing action was possible, because the explanations given by one member were almost never complete, and the incompleteness invited the other member to provide the missing pieces from her repertoire. (Miyake, 2008, p.463)

Taking each individual as a smaller unit of analysis contributes to demonstrating finer mechanisms built in the collaborative process.

3 The jigsaw method for constructive interaction

If we assume that individual differences are precious sources for collaboration, we can design collaborative situations from different perspectives. For example, when the balance or symmetry of individual contributions is taken as a problem (*equity* in Buisine, 2010), co-construction theorists often tend to provide with more chances to share the same information or views among members throughout the collaboration. From our perspective, however, this is not a problem, because monitors can learn much from collaborations even if they talk little (see Hatano & Inagaki, 1991, for empirical data). Yet, if we take this as a problem, we solve it by attributing more differences and greater authority to individuals. It will also contribute to increasing chances of role exchange, because every member has her or his *own* task and can engage in task-doing. This is the concept of *distributed expertise* or *legitimization of differences* (Brown, 1997), and the jigsaw method (Aronson & Patnoe, 1996) is suitable for doing this.

However, there is little research that compares the jigsaw method with the more convergence oriented method directly. Thus, we compared two collaborative activities for college students' learning of cognitive science, specifically integration of classic literature of twelve research pieces. One method is the jigsaw that assigns different pieces to different students and makes them exchange what they learn. The other is a simpler type of collaboration that gives all pieces to all students in a serial order, which should provide members with more shared information and knowledge.

Comparing the results, we found that the jigsaw method promoted integration of research pieces more than the simpler method. Detailed analyses of the students' discussions revealed that distributed expertise promoted each individual's solid understanding of the assigned piece, which also served as a basis for integration. In contrast, the students in the serial-ordered collaboration did not refer to the contents of research pieces, as if they were taken for granted, which led themselves only to vague abstraction of overall themes. Also, the total amount of verbalization is more balanced in the jigsaw method, even though the members often exchanged roles. In the serial-ordered collaboration, strong members often took the floor and forced others to converge to their opinions without serious argumentation of the content material.

These results indicate why the jigsaw worked. In this method, each member engaged in constructing explanations of her or his own assigned material, and when explaining it to the others s/he gained slightly objective comments. In integrating multiple materials, each member actively participated in the conversation, rooting her or his explanation in the assigned material yet utilizing its essence. In this sequence, gradual abstraction could take place from literal reading of the material through sense-making to relation-making among several materials. We also observed that the jigsaw students often changed their axes of

integration of research pieces, which implies their deliberate nature of thinking as well as enriched understanding of original materials. We have been collecting and analyzing in details this kind of comparison data, computer-mediated or non-computer-mediated, of various tasks in various domains (lecture comprehension in Shirouzu & Miyake, 2007; mathematical proof in Shirouzu, 2009). I hope future discussions on how to raise and assess the quality of collaboration.

4 References

Aronson, E., & Patnoe, S. (1996). *The jigsaw classroom: Building cooperation in the classroom.* New York: Addison Wesley Longman.

ATC21S, (2010). *Classroom learning environments and formative evaluations.* In Draft White Papers of Assessment & Teaching of 21st century skills, http://www.atc21s.org/home/

Baker, M. (2010). In this volume.

Bereiter, C., & Scardamalia, M. (1993). *Surpassing ourselves: An inquiry into the nature and implications of expertise.* La Salle, IL: Open Court.

Buisine, S. (2010). In this volume.

Brown, A. (1997). Transforming schools into communities of thinking and learning about serious matters, *American Psychologist*, 52(4), 399-413.

Forman, E. A., & McPhail, J. (1993). Vygotskian perspective on children's collaborative problem solving activities. In: E.A. Forman, N. Minick and C.A. Stone (Eds.) *Contexts for learning: Sociocultural dynamics in children's development,* 213-229. New York: Oxford University Press.

Hatano, G. & Inagaki, K. (1991). Sharing cognition through collective comprehension activity. In L. B. Resnick, J. M. Levine & S. D. Teasley (Eds.) *Perspectives on socially shared cognition.* Washington, D C: American Psychological Association, 331-348.

Miyake, N. (1986). Constructive interaction and the iterative process of understanding. *Cognitive Science*, 10, 151-177.

Miyake, N. (2008). Conceptual change through collaboration, In S. Vosniadou (Ed.), *International handbook of research on conceptual change*, 453-478. New York: Routledge

Roschelle, J. (1992). Learning by collaborating: Convergent conceptual change. *The Journal of the Learning Sciences*, 2, 235-276.

Shirouzu, H. (2009). The jigsaw as an enhancer for solving challenging math problems. *American Educational Research Association*, San Diego, U.S.A.

Shirouzu, H., & Miyake, N. (2002). Learning by collaborating revisited: Individualistic vs. convergent understanding. *Proceedings of the 24th Annual Conference of the Cognitive Science Society,* p.1039. Washington, U.S.A.

Shirouzu, H., & Miyake, N. (2007). Scaffolds for lecture comprehension: Video-jigsaw and stop-and-think using a video system. In T. Hirashima et al. (Eds.), *Supporting Learning Flow through Integrative Technologies (Proceedings of ICCE 2007)*, pp.175-182, Amsterdam.

Shirouzu, H., Miyake, N., & Masukawa, H. (2002). Cognitively active externalization for situated reflection. *Cognitive Science*, 26, pp.469-501.