A New Approach to Lesson Study Practice in Japan from the DBIR Perspective

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Abstract: We report our progress in developing continuous improvement for educational practices in a local school district in Japan. Utilizing design-based implementation research (DBIR) design principles, we started to identify a focus for joint work with a school. After three years of searching for and identifying a focus for joint work (development and evaluation of student collaboration skills), a teacher and researchers started collaborative DBIR research practice as a new lesson study using a new evaluation tool, socio-semantic network analysis of student discourse. In addition to an ordinary post-lesson colloquium, we performed a second post-lesson colloquium that combined researchers' discourse analysis with teacher observations and evaluations to share and discuss. The second post-lesson colloquium was found to significantly facilitate comprehension of how students engaged in student learning.

Keywords: design-based implementation research, lesson study, socio-semantic network analysis, post-lesson colloquium

Background and research purpose

Design-based research (DBR) is now widely pervasive (Barab & Squire, 2004; Sandoval & Bell, 2004), but we sometimes experience communication breakdowns between practitioners and researchers in Japan. This might be due to the unique historical background of lesson study practice in Japanese teacher communities. There, lesson study is an established professional development practice in which teachers exchange ideas for improving classroom lessons, share lesson plan documents, act out lessons for their colleagues to observe, and discuss and analyze how lessons should proceed based on lesson plans across a variety of scales, from individual schools to national events (Lewis, Perry, & Murata, 2006). On the surface, lesson study practice is very similar to DBR in that it takes PDCA (plan–do–check–act) steps. However, practitioners and researchers approach educational practices from different perspectives. First, teachers are more concerned with localized how-to and know-why knowledge, whereas researchers are more interested in the transferability of practitioners' knowledge (Bereiter, 2014). Second, teachers do not necessarily have epistemic beliefs for the knowledge society regarding their teaching (Oshima et al., 2006), most of which are not related to new perspectives of learning as knowledge creation (Paavola & Hakkarainen, 2005). To bridge the gap between practitioners and researchers in educational practice, we applied an interventionist approach (Penuel, Cole, & O'Neill, 2016) from the perspective of design-based implementation research (DBIR) (Fishman et al., 2013; Penuel et al., 2011) to design the lesson study for facilitating teachers' comprehension of student engagement in their collaboration by using a new evaluation technology.

An interventionist approach to lesson study in japan

DBIR studies (e.g., Fishman et al., 2013; Penuel et al., 2011) propose four design principles for the sustainable improvement of educational practices at scale. First, a DBIR team should form around a focus on persistent problems from multiple stakeholder perspectives. Our DBIR team comprised teachers, a principal, a member from the district's educational department, and researchers like us. The team was formed at the request of the district's educational department for school reform to bring our learning sciences expertise into classroom practices. Before starting our lesson study practice with teachers, we visited the school several times to observe and discuss their practices. Through discussions with the principal and teachers, we extracted two problems. One problem was that instructional goals were based on national curriculum guidelines. Although every school is obliged to follow these guidelines, doing so is sometimes not feasible when students have standardized scores below 40 for knowledge corresponding to their grade level. Researchers provided teachers with the concept of learner-centered approaches, and decided to start lessons by setting a level of expertise that students could build on. Another challenging problem was new assessments that appropriately evaluate improvement in students' collaboration skills and their conceptual understanding of the study topic. Standardized tests do not capture fine improvements in student expertise during collaboration. Test scores did not correspond with teacher

assessments of their students' understanding. To solve this problem, we proposed the use of video-based analysis and a socio-semantic network analysis of students' discourse that we developed (Oshima, Oshima, & Matsuzawa, 2012).

Second, our team committed to iterative and collaborative design. Our collaborating school had engaged in the iterative cycle of their lesson study before we began the collaboration. We further implemented know-why (theoretical) knowledge of how to design lessons by using jigsaw instruction. More specifically, we introduced the concept of constructive interaction (Miyake, 1986) for designing expert group activities. Even when students tackle the same content, they can bring different perspectives to the materials. Differences in student perspectives constructively induce interaction. We discussed how to design study documents and worksheets so that every student could contribute new perspectives. In jigsaw activities, where students having studied different materials gather and collaboratively integrate knowledge sources, students are supposed to engage in productive interaction across multiple zones of proximal development (ZPD) depending on the knowledge sources examined (e.g., Brown & Campione, 1996). To facilitate interactions across multiple ZPDs, we examined how study materials in the expert group would interact to help students come up with ideas for forest management.

Third, we were concerned with developing theory and knowledge related to both classroom learning and implementation through systematic inquiry. To develop theoretical knowledge related to classroom learning, we decided to implement a new assessment technology, socio-semantic network analysis (SSNA) of discourse (Oshima et al., 2012). SSNA was used in this study as an assessment tool for researchers to analyze student discourses during jigsaw group activities, then provide teachers and other stakeholders with feedback on how they engaged in collective knowledge advancement. (We discuss SSNA in more detail in the "Lesson Study from the DBIR Perspective" section). Furthermore, through implementation of the new assessment tool for student discourse, we revised our lesson study practice by having another post-lesson colloquium a month after the ordinary post-lesson colloquium conducted on the research lesson day. The two post-lesson colloquia were expected to facilitate our scrutiny of research lessons from multiple stakeholders' perspectives and to enable more systemic inquiry.

Finally, we were also concerned with developing capacity for sustaining systemic change. The education department provided funding of seven million yen (about US$60,000) to renovate infrastructure and to purchase information and communications technology such as iPads for students to use during inquiry-based learning. We discussed with teachers and the principal how they wished to renovate their learning environment, and coordinated the construction and purchase processes. The educational department asked us to additionally coordinate renovation of the learning environment at a high-performance school, to implement what they called "sandwiching" tactics. That is, they thought that if we succeeded in reforming both high- and low-performing schools, other schools might be more interested in similar reforms.

Lesson study from DBIR perspective

Purpose of the lesson study in DBIR

The lesson study practice reported in this study was a sub-component of our DBIR project with highest- and lowest-performing high schools. In both schools, we collaborated with teachers of different subjects. The high-performing school was a top-quality college preparatory school. Most graduates go on to colleges or universities after graduation. The low-performing school was an industrial high school for agriculture and forestry for students with low learning skills and motivation. The educational department requested that the researchers help both schools establish new learning cultures based on the idea of 21st-century skills (Griffin, McGraw, & Care, 2012). To that end, the educational department decided to encourage schools to implement jigsaw instruction as a collaborative learning method. Our mission in lesson studies at the two high schools was to create a new style of learning activity that applies students' prior knowledge and expertise to improve jigsaw instruction. We previously reported our progress in developing a learning culture at the prep school at CSCL 2015 and 2017 (Oshima et al., 2015, 2017). In this paper, we report on progress in our collaborative lesson study at the agricultural and forestry high school.

Research lesson

The study topic was forest management. Seven twelfth-grade students had engaged in extensive forestry studies and had managed practical forest divisions for three years. The instructional goal was understanding how to manage forests in consideration of their carbon fixation function. During 50-min class periods, expert group students were divided into three groups to study 1) determining the size of their practical forests using a digital planimeter, 2) figuring out how much carbon dioxide per hectare is fixed by trees of different ages by examining

a graph, or 3) calculating how many trees are needed to fix the amount of carbon dioxide produced by a person in Japan by examining a table of tree volumes and carbon fixation amounts. In jigsaw group activities during the next class period, students from different expert groups were grouped to exchange ideas and integrate knowledge regarding how forest divisions should be managed to maximize carbon dioxide fixation. Student activities were video recorded using 360-degree cameras and microphones, and their discourses were transcribed for SSNA.

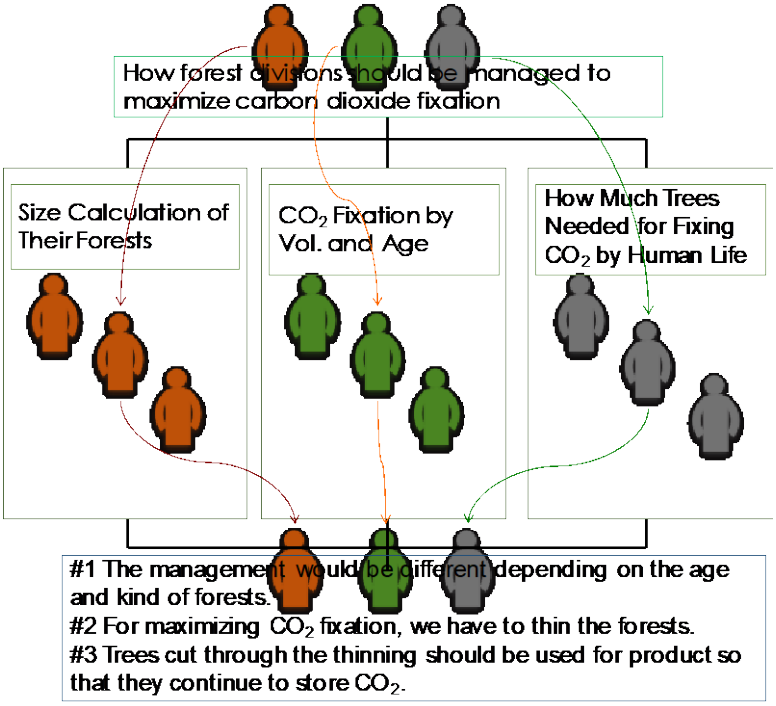

Figure 1. Participatory structure of the jigsaw instruction.

Socio-Semantic Network Analysis as a new assessment tool for teachers and researchers to share and examine student discourse

In the computer-supported collaborative learning research (CSCL) field, there have been discussions on the advantages of using social network analysis (SNA) to investigate collective knowledge advancement (e.g., Martinez et al. 2003; Reuven et al. 2003). De Laat et al. (2007) proposed an approach to synthesizing and extending comprehension of CSCL teaching and learning processes to balance SNA, content analysis, and critical event recall. In the complementary approach, SNA was used to study interaction patterns within a learning community in the network, and to study how participants share and construct their knowledge. De Laat et al. (2007) concluded that the inclusion of SNA in any multi-method approach is advantageous, because it provides researchers and learners with tools for illustrating comprehension and cohesion of group activities, as well as providing researchers a method for selecting appropriate groups to study. For instance, to analyze student collective knowledge-building in Knowledge Forum, Zhang et al. (2009) implemented a complementary approach that used SNA to visualize and compare classroom collaboration among fourth-grade elementary school students over three years. An analysis of online participatory patterns and knowledge advancement indicated that this learning process effectively facilitated knowledge advancement through critical changes in organizations within the classroom, from fixed small groups in the first year of the study to appropriate collaboration through the dynamic formation of small teams based on emergent goals.

Based on those preceding studies, we extended the potential of SNA by developing a different type of network, the socio-semantic network. Ordinary SNA illustrates the social patterns of learners. As de Laat et al. (2007) suggested, this approach is thus informative when examining developments or changes in the participatory structure of a community. However, several studies have argued that existing social network models cannot examine how collective knowledge advances through learner collaboration (Oshima et al., 2012; Schaffer et al., 2009). Instead, we proposed a procedure similar to ordinary SNA but with a different type of social network, one based on the words learners use in their discourses. Figure 2 shows the interface of a SSNA tool called Knowledge Building Discourse Explorer (KBDeX) (Oshima et al., 2012). Discourse datasets in CSV

format can be input into KBDeX and analyzed by visualizing a socio-semantic network of vocabulary of researcher concern. In addition to visualization of the socio-semantic network, KBDeX also provides researchers with several metrics of network structures, such as centralities. The visualization of student discourse, a socio-semantic network of vocabulary in particular would help practitioners to examine how students collaborate from the perspective of collective knowledge advancement.

In their ordinary post-lesson colloquium after the research lesson, practitioners discuss how the lesson unfolded by relying only on observation notes. They also sometimes use video data, but such use is not systematic and shows certain points of discourse or activities that they consider as important for reflection. Computational analysis tools like KBDeX would further extend practitioners' reflections in post-lesson colloquia as follows. First, they can easily view and compare total processes of student discourse between groups. When practitioners examine the discourse process of a given group, they can stop the visualization and freely review what happened during collaboration, rewinding to the original discourse and conducting brief conversation analysis. After examining all groups, they can be categorized into cohorts representing specific interaction patterns. Practitioners can also examine student contributions to collective knowledge advancement through discourse by discarding exchanges from the discourse datasets to reveal changes in the vocabulary network structure. Significant structural changes are characteristic of significant student contributions.

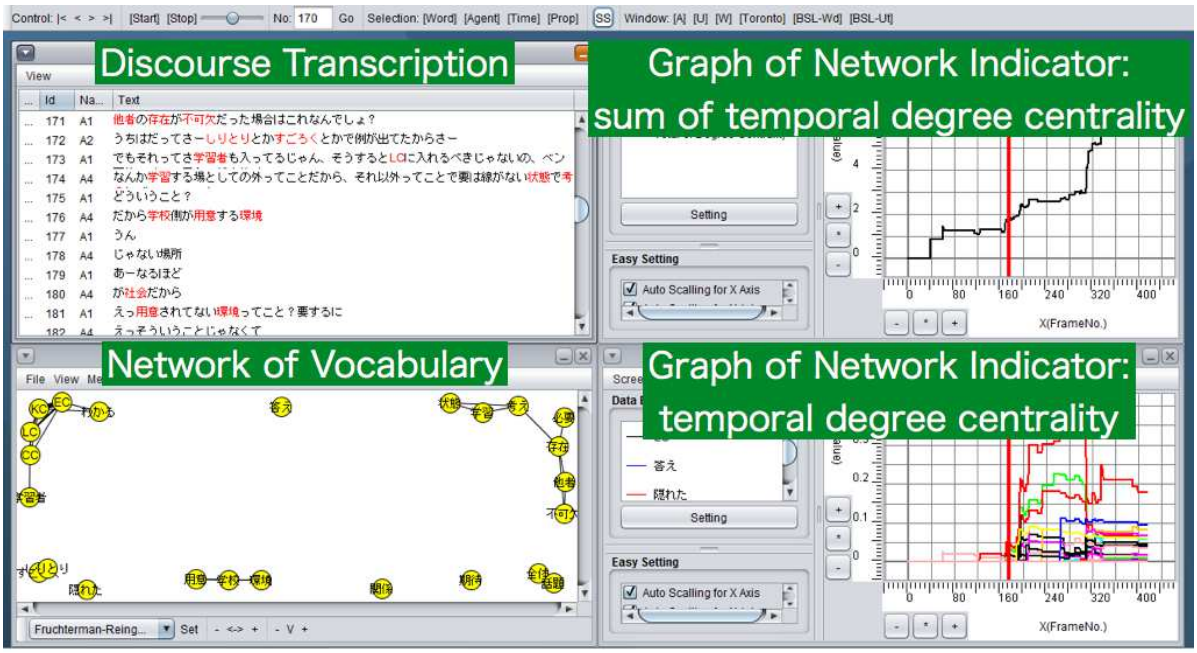

Figure 2. Socio-semantic network analysis with KBDeX.

In ordinary lesson study, teachers conduct a post-lesson colloquium on the same day as the research lesson. In our DBIR lesson study, we added a second post-lesson colloquium in which researchers used SSNA to analyze student discourse in the jigsaw group and to give teachers feedback regarding researcher findings for comparison with teacher reflections in the first post-lesson colloquium. Colloquia were video recorded and transcribed. Here, we report on researchers' SSNA analysis of student discourse and how findings compared with teachers' reflections in the first post-lesson colloquium to develop new ideas for improving lesson plans for the next year.

SSNA of student discourse in jigsaw group activities

To examine how students in the jigsaw group activities engaged in collective knowledge advancement, we selected a list of vocabulary related to the materials studied in the expert groups and visualized the selected vocabulary network of their discourse (Figures 3 and 4). Each visualization shows how a student contributed to collective knowledge advancement. Red nodes in the visualization represent vocabulary terms used by the student.

In both groups, student discourses were visualized as well-structured vocabulary network. Most words representing three expert-group documents were used in the discourses and interconnected. However, when we

examined how many words each student used and which expert documents the words came from, differences in student contributions between the groups were revealed. Our analysis suggested that jigsaw group 1 better advanced collective knowledge than did group 2. This finding contradicted teacher reflections in the first post-lesson colloquium. In jigsaw group 1, students used many words from all the three expert group documents in their discourse. This revealed that student contributions to collective knowledge advancement were distributed and overlapped among students, who attempted to link their ideas with others from their expert perspective. In contrast, one student (2c) in jigsaw group 2 took the lead in integrating different pieces of knowledge, followed by two other students (2a and 2b). The fourth student (2d) used a single word related to his expert group document but did not contribute at all. The teacher evaluated student 1a and 2a as unmotivated ones based on his classroom practices ("They do not like to pay attention to the study topic, instead playing games on their smartphones during class."), but our SSNA found that they played important roles in integrating different pieces of knowledge from expert documents. The results of our SSNA suggested that these learners did not meet teacher expectations. Rather, they contributed to collective knowledge advancement by making utterances that linked different ideas or helped others to do so.

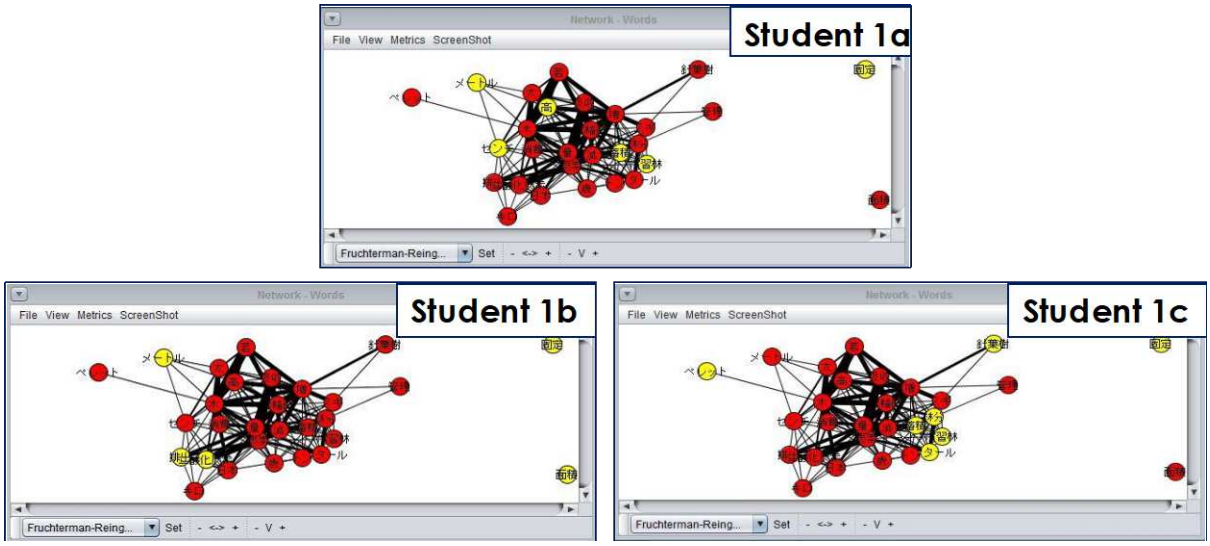

Figure 3. Socio-semantic network of vocabulary in a jigsaw activity by group 1.

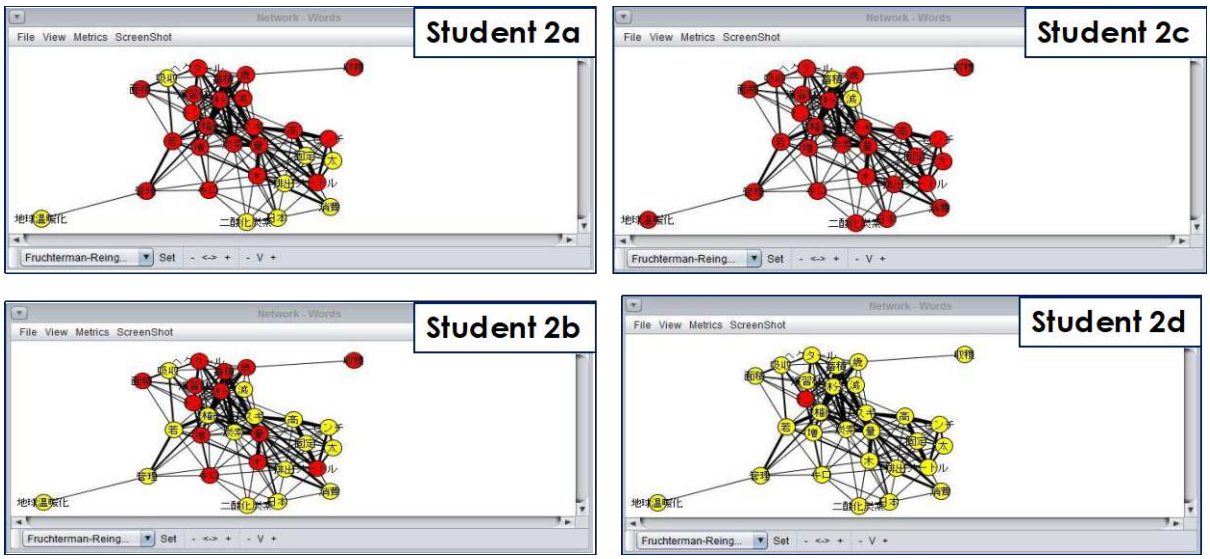

Figure 4. Socio-semantic network of vocabulary in a jigsaw activity by group 2.

Teacher reflections on student learning based on observations and SSNA at post-lesson colloquia

We conducted the second post-lesson colloquium one month after the research lesson. At the second post-lesson colloquium, researchers first explained their analysis of student discourse in jigsaw group activities, then accepted questions from practitioners. We as researchers demonstrated visualization of student discourse from beginning to end. We then summarized our SSNA results as described in the previous section. When the research lesson teacher saw the vocabulary network visualized for jigsaw group 2 compared with group 1, he recognized that advancement by group 1 exceeded that of group 2. This awareness led him to ask the researchers to demonstrate in detail how group 1 engaged in their discourse. Researchers ran KBDeX to visualize time-serial changes in vocabulary network structure, stopping at times of critical change. We discussed how each student in group 1 contributed to collective knowledge advancement by looking back at the original transcript and video.

During the second post-lesson colloquium, teachers and researchers could come up with issues for further research lessons. First, we need to redesign the lesson plan so that student contributions during group activities might be more democratized. The remarkable difference in student contributions to their collective discourse in KBDeX demonstrated that the jigsaw participatory structure was insufficient for supporting students in productive collaboration for knowledge creation. Further instructional intervention (namely, scaffolding) should be implemented. We decided to further modify the expert group documents and the jigsaw group activity worksheet in order to democratize student contributions. Second, teachers realized that student motivation was not innate, but rather resulted from interaction with the environment. SSNA clearly showed that typically "unmotivated" students productively engaged in collaboration though discourse. The research lesson teacher was highly interested in what motivated students to work on the study topic in the research lesson. The researchers were asked to provide a detailed analysis of discourse to allow specification of possible factors for motivation and lesson plan redesign based on the analysis.

Discussion

We started our DBIR by searching for and deciding on a focus for joint work with teachers and the school. We spent three years identifying the focus for joint work, development of collaboration skills as an instructional goal, and implementation of a tool (SSNA) for evaluating changes in student discourse at finer granularity. In this paper, we reported on how we designed a new lesson study practice using DBIR as an extension of teachers' original practices. Here, we discuss how our interventionist approach would make our collaboration sustainable in the future.

First, we did not have to introduce completely new ideas for lesson plans. Teachers at the school had already started lesson study for jigsaw instruction. What we attempted was to help them to examine their instruction and lesson plans from a perspective of learning as knowledge creation, that is, how students engage in collective knowledge advancement during discourse. Many teachers are resistant to theory, which they consider unhelpful for creating lesson plans and conducting them in the classroom. During our joint three-year endeavor to search for a focus for our work, we successfully developed a trust relationship by sharing lesson study practices many times. After the three years, teachers requested that we implement something from our theoretical perspective. We felt that it was time for more rigorous lesson research by intimately collaborating with teachers as reflective practitioners.

Second, to more rigorously examine student discourse, we proposed that the school implement SSNA as an assessment tool. We recommended this because we considered the tool as needed for evaluating student discourse. Before starting our research lesson in the year, we introduced SSNA at another meeting and requested that they use it for the evaluation. The school was interested in implementing this new assessment tool. Implementation of the new tool consequently led to the second post-lesson colloquia, which were found to be productive for several reasons. One reason was that time (a month) had passed since the research lesson. The research lesson teacher and researcher could step back a bit and discuss how the lesson went on based on a variety of evidence. Doing so might facilitate us to "reflect on our action rather than reflection in action" (Schön, 1983). In his seminal book on reflective practitioners, Schön defined two types of reflection that practitioners engage in. Reflection in action is a process by which practitioners reflect on their present action.

> When someone reflects-in-action, he becomes a researcher in the practice context. He is not dependent on the categories or established theory and technique, but constructs a new theory of the unique case. (Schön, 1983, p. 68)

In our research lesson practice, the first post-lesson colloquium was an opportunity for the teacher to engage in reflection-in-action since the lesson was in the middle of a curriculum of the study unit. As Schön described, the teacher realized "new" incidents that were unexpected before the lesson and attempted to explain why they

happened. In his attempt, there was no space for us to introduce theories to his reflections, because he dealt with several incidents case-by-case. Over the three years of our experiences with teachers, this phenomenon was typically seen in post-lesson colloquia right after the research lesson. At the second post-lesson colloquium, we succeeded in implementing reflection on action.

> We reflect on action, thinking back on what we have done in order to discover how our knowing-in-action may have contributed to an unexpected outcome. (Schön, 1983, p. 26).

At our second post-lesson colloquium, we brought a variety of evidence on research lessons from multiple stakeholders' perspectives. Although evidence from different perspectives suggested different conclusions, the contradictory relation among different pieces of evidence stimulated our boundary-crossing effort (Engeström, 1999, 2011) to develop more comprehensive understanding of learners.

In this way, our interventionist approach to lesson study practice promoted a new style of lesson study through partnerships among teachers, the school, the district education department, and researchers. In future research, we will further examine whether this change represents just another proof of concept or continuous improvement. The following studies are further necessary and promising. First, we have to conduct more rigorous qualitative analyses of how our designed post-lesson colloquium has influence on the critical change in teachers' epistemic beliefs and comprehension of students' performance. We can examine how we as a group of practitioners and researchers constructed our shared understanding of student performance based on the results of SSNA by conducting the conversation analysis. Second, our report here is only the result in the first year of our endeavor. Through the iterative lesson studies in the DBIR framework, we can further examine our hypothetical design principles of the post-lesson colloquium.

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