학습자중심교과교육연구 http://dx.doi.org/10.22251/jlcci.2016.16.10.565
Journal of Learner-Centered Curriculum and Instruction
2016. 제16권 제10호, pp. 565-591.

Learning about Collaborative Knowledge Building: A Case of Future School in Singapore*

Hyo-Jeong So(Ewha Womans University)**
Xujuan Zhang(First High School of Changsha County)
Esther Tan(Open University of the Netherlands)

<ABSTRACT>

This study discusses the design, enactment and evaluation of a Collaborative Knowledge Building (CKB) workshop, designed to resolve the prevalent problem that Asian students tend to lack the necessary skills and appreciation for collective cognitive responsibility. The study was conducted with Secondary one (13-year-old) students in one of the future schools in Singapore. The students participated in the CKB workshop that was designed with the material and structural conditions (i.e., idea cards, knowledge wall, opportunistic grouping, reflective presentation) coupled with explicit instruction to help them learn about collaborative knowledge building skills. For evaluation, the participants completed the perception survey about collaborative learning attitudes after the workshop. We also collected and analyzed discourse data of one selected group's discussion. The findings reveal that the students showed overall positive perception about collaborative learning experiences in the workshop and the indicators of knowledge building discourse moves in the group discussion. However, the students still needed more guidance in the process of teamwork, particularly in consensus building due to the tendency to reach a quick consensus.

★ Key words: knowledge building, collaborative learning, embedded instruction, collective cognitive responsibility

* This research was supported by the FutureSchools@Singapore project under the Interactive Digital Media (IDM) in Education Research and Development Programme, National Research Foundation. Singapore
** Corresponding author: hyojeongso@ewha.ac.kr

Ⅰ. Introduction

In the era of knowledge society, educational reform movements around the world have increasingly emphasized the need to develop students' competencies for knowledge creation. This rising awareness stems from the realization that greater interconnectivity and global mobility in the 21st century would require our students to acquire the competencies to work collaboratively and creatively beyond the mere acquisition and improvement of personal knowledge. The Knowledge Building Pedagogy places a great emphasis on students' competencies for collective inquiry and responsibility for the pedagogy that "what the community accomplishes will be greater than the sum of individual contributions" (Scardamalia & Bereiter, 2003, p. 1370). Hitherto, there have been extensive research studies around the world on this pedagogical approach (e.g., Lee, Chan, & van Aalst, 2006; So, Seah, & Toh-Heng, 2010; So, Tan, & Tay, 2012; van Aalst & Truong, 2011; Weinberger & Fischer, 2006; Zhang, Hong, Scardamalia, Teo, & Morley, 2011; Zhang, Scardamalia, Lamon, Messina, & Reeve, 2007; Zhang, Scardamalia, Reeve, & Messina, 2009). However, only a few studies have actively attempted to resolve the prevalent problem, i.e., how to develop in students the necessary skills and appreciation for collective cognitive responsibility in knowledge building. Here, collective cognitive responsibility (Scardamalia, 2002) refers to both social and cognitive aspects, which students as members of the group and community take collective responsibility for collaborative knowledge advancement. Taking over such high-level shared responsibility in social and cognitive endeavors is particularly challenging to students in Asian schools where the classroom culture tends to be more teacher-centric and task-focused than student-centric and understanding-focused (Oshima et al., 2006; So et al., 2010; van Aalst & Truong, 2011).

On the whole, our research experiences indicate that Asian students still needed more explicit and specific guidance in the knowledge building instructional approach, in particular, in understanding that this pedagogy does not equate the regular group work in the classroom. This observation is consistent with other previous research in learning sciences arguing that an important reason why students have difficulty in collaborative learning is not simply because they lack intellectual abilities, but they do not know how to collaborate and reflect (Rummel & Spada, 2005; White & Frederiksen, 1998). On the similar note, the need to make pedagogical principles explicit to students has been raised by Scardamalia and

Bereiter (2006), where they contend that "for decades educators have promoted constructivist ideas among themselves whereas their students have been expected to carry out constructivist activities without access to the constructivist ideas lying behind them" (p. 108). It is thus apparent that if we as educators and researchers want to engage students in knowledge-building communities, we would have to make the core ideas and principles of knowledge building more accessible to students.

The collaborative knowledge-building (CKB) workshop discussed in this paper is, therefore, a deliberate attempt to help students learning about how to streamline the process of working with ideas following the principles of knowledge building. The goal of this research is two-fold: 1) we present how the CKB workshop was designed and enacted by incorporating core principles of knowledge building pedagogy, and 2) we evaluate how the workshop design affected students' perception and discourse moves about collaborative knowledge building.

Ⅱ. Theoretical Background

1. Knowledge Building and Enculturation

Knowledge building as a pedagogy is premised on core guiding principles rather than rigid activity structures. Scardamalia (2002) elaborated a set of 12 interconnected principles in knowledge building encompassing social-cognitive and technological dynamics. The core principles include 1) real ideas, authentic problems; 2) improvable ideas; 3) idea diversity; 4) rise-above; 5) epistemic agency; 6) community knowledge; collective responsibility; 7) democratizing knowledge; 8) symmetric knowledge advancement; 9) pervasive knowledge building; 10) constructive use of authoritative sources; 11) knowledge building discourse; and 12) embedded and transformative assessment. In terms of technological dynamics in support of knowledge building principles, Knowledge Forum has been developed as an online space where students can work collaboratively toward advancing ideas as a community. The use of knowledge building principles along with Knowledge Forum as a technological support has demonstrated the possibility of initiating students into a knowledge-creating culture. For example, Zhang et al. (2009) reported a three-year research implementation in a Grade 4 classroom in Toronto where students were able to assume a high-level of cognitive collective

responsibility for sustaining knowledge advancement in science learning. The success for acculturating students into a knowledge-creating culture was attributed to the distributed and opportunistic structure for collaboration that turned over cognitive responsibility from teachers to students and allowed students to work with emergent interests and ideas.

However, it is important to note that knowledge building is not a short-term intervention but a long-term enculturation process. van Aalst and Truoung (2011) argue that there is a significant gap in the existing literature as little is known about how knowledge building as an enculturation process work with students and teachers who are new to this type of constructivist approaches. In particular, knowledge building research conducted in Asian contexts has underscored socio-cultural constraints regarding the difficulty of shifting a classroom culture from knowledge telling to knowledge building (Chan, 2011; Oshima et al., 2006; So et al., 2010). One of the socio-cultural constraints in Asian contexts is that students' epistemic beliefs place emphasis on individual understanding and achievement. This gives rise to the need to guide Asian students to see and experience the value of working with ideas collaboratively for collective knowledge advancement.

2. Learning to Collaborate: Explicit vs. Embedded Instruction Approaches

Gillies and Ashman (1996) argue that many teachers tend to assume that students will demonstrate collaborative skills, but in reality only a small number of students exhibit such group behaviors. To equip students with an ability to co-construct knowledge, neither theoretical inculcation nor vacuum practice is sufficient. Johnson and Johnson (1989) urge to go beyond theoretical guidance, "not only must group members be taught the skills required for effective collaboration, but they must also be prepared, and given the opportunity, to use them" (p. 188).

While there seems to be a broad agreement that effective collaboration must be learned and practiced, how to do so remains a challenging issue. Notwithstanding the presence of various approaches to instruct students about how to collaborate, but each approach differs greatly in the provision of scaffolds: the type and the amount of scaffolds. There is a lack of systemic research on the condition and context where these approaches have yielded the desired learning outcomes. On

one extreme, explicit instruction is advocated where lessons are specifically designed to provide students with direct guidance about collaborative skills. On the other extreme, embedded instruction is fostered where collaborative skills are embedded in the content learning without explicit teaching of process skills.

First, explicit instruction is employed to guide students towards learning new skills and concepts through clear explanation and demonstration. Explicit instruction is a direct approach to teaching "with a series of scaffolds where students are guided through the learning process with clear statements about the purpose and rationale for learning the new skill, clear explanations and demonstrations of the instructional target, and supported practice with feedback until independent mastery has been achieved" (Archer & Hughes, 2011, p. 1). Hence, it is important to understand that explicit instruction is not to dictate instructions, but rather, to provide strong instructional support with necessary scaffolding. Teachers are still in the capacity to exercise judgment and to withdraw the scaffolds when students show readiness to assume greater agency in their own learning.

There are several studies that have proven the effectiveness of explicit instruction to hone students' collaborative and problem-solving skills. Gilles (2003) present a series of five research studies that were conducted to teach primary-school children about collaborative know-hows. Students received collaborative skill training where teachers taught them about the process and value of good collaboration, and practiced interpersonal and small-group skills such as providing constructive feedback on ideas, clarifying differences of opinion and monitoring the group's progress. On the contrary, the untrained group was provided with the opportunity to work together without any explicit instruction about the collaboration process and skills. The result revealed that students in the trained group were more cooperative and obtained higher learning outcomes than those in the untrained group, thereby underscoring the importance of explicitly structuring small-group work in classrooms.

Second, embedded approaches do not involve direct teaching of process skills, but a mechanism for "structuring the collaborative process in order to favor the emergence of productive interactions" (Dillenbourg, 2002, p. 62). In the field of computer-supported collaborative learning (CSCL), how to structure collaborative processes has been actively researched, with the integration of technological support in forms of collaborative scripts and modeling methods. Collaborative scripts are based on the idea of scripted cooperation where "the roles played by

the interacting partners and the processing activities in which they engage are specified" (O'Donnell, 1999, pp. 189-190). On the contrary, model approaches provide learners with an opportunity to observe the behaviors of the model partners that are specifically designed to exemplify aspects of a good collaboration. Rummel and Spada (2005) conducted an experimental study where they compared the effect of collaboration model and collaborative scripts supported in a computer-mediated environment on graduate students' ability to collaborate. It was found that both collaboration model and script showed positive effects on the collaborative process, outcome and individual knowledge about features of good collaboration. Similarly, Cortez et al. (2009) introduced the learning-to-collaborate-by collaborating (LCC) process where learners were supported by the use of a mobile application specifically designed to guide the process of monitoring group work and receiving feedback in real time. The participants were able to show improvement in teamwork skills and willingness to work in a team.

Despite substantial progress on this research theme, little is known about under what conditions explicit instruction or guided approaches are likely to yield productive outcomes. For instance, Dillenbourg (2002) cautions against over-scripting collaborative process and discourse as such attempts may disturb natural interactions and problem solving processes, increase cognitive load, and lead to didactised and goalless interactions. On a similar note, there are dangers of providing too little guidance as students may be lost and frustrated without access to necessary guidance and resources. Kirschner, Sweller, and Clark (2006) argue that minimal guidance is effective only when learners have high prior knowledge that provides internal guidance. Taken together, the question whether direct instruction or minimal guidance is effective should not be conceived as a dichotomous decision, but be viewed from the consideration of situational variables such the level of student knowledge and prior collaborative learning experiences, the type of content learning, and the socio-cultural factors affecting teaching and learning processes in local contexts. In this study, therefore, we posit that under the situation where both teachers and students are new to a knowledge building pedagogy, both explicit instruction and guided approaches have distinctive values and role to assimilate students into a knowledge-creating culture, and examine how the integration of the two approaches help students learn to collaboratively build knowledge.

Ⅲ. Research Context and Method

1. Research Context and Motivation

This research was conducted with Secondary One students in one of the future schools in the FutureSchool@Singapore program. Twenty students participated in two sessions of the CKB workshop on the consecutive days and each session lasted for two hours. The participants were 13-year-old, and considered to be high achieving students in their academic ability according to the teacher's comment.

The central idea in the future school project is to transform schools for future challenges by leveraging pedagogical and technological innovations. As such, one of the desired competencies in the 21st century is to nurture students to become collaborative and creative problem solvers who are self-motivated and inquiry-minded. During three-year design research work in this future school, the research team worked closely with the teachers in Humanities (i.e., Geography & Humanity) to design and implement various learning activities toward promoting pervasive knowledge building practices in and out of school, particularly with the mediation of mobile technologies.

However, one of the tensions that we faced in the research trajectories was the conflict in students' espoused beliefs and real practices about collaborative knowledge building. That is, while students were able to articulate the importance of collaborative knowledge building, in reality they tended to adopt task-oriented and division-of-labor approaches. For instance, when students participated in outdoor mobile learning activities, they showed competitive and answer-seeking behaviors, without sufficiently taking advantages of the rich resources and interaction available in the physical environment. Based on this observation, the research team and teachers reached a mutual consensus that there is a critical need to make the core principles, terms and practices of knowledge building more explicit to students. The workshop reported in this paper is a deliberate attempt to guide students to learn about the process and principles of collaborative knowledge building through carefully designed activities.

2. Data Collection and Analysis

For data collection and analysis, we collected multifaceted data such as a) the

collaborative learning survey, b) text written on idea cards, and c) groups' discourse and presentations. While the collaborative learning survey was administered to all students who attended the workshop, qualitative data such as idea cards and group discourse were captured from one focus group of four students randomly selected by the researchers for an in-depth qualitative analysis.

As quantitative measures, we used the 'Collaborative Learning Attitude Survey' adapted from Brown, Eastham and Ku (2006) to examine students' perceptions about their collaborative knowledge building experience in the workshop. Since the sample size was small, we were not able to conduct statistical analysis to examine the reliability of the sruvey. Instead, to ensure the validity of the survey, we selected the instrument that was validated in the previous study, and the content of the survey items were validated with the experts and th teachers prior to the adminstration. The survey includes 28 items on the five key constructs: a) self-perception (e.g., perception about own participation in group work), b) perception of team members (e.g., team members' demonstration of respect and equitable contribution), c) teamwork (e.g., openness of ideas and adherence to the team agreement), d) progress (e.g., collaborative efforts in problem solving), and e) satisfaction (e.g., enjoyment of working with group members). All items are based on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

Beyond the overall perception data, we wanted to examine how and to what extent students as a group exhibit discourse moves aligned with the principles of knowledge building throughout the four-phased inquiry cycle. As such, we collected and analyzed multiple qualitative data at different phases of knowledge building. <Table 1> presents an overview of data sources for each phase. During the idea generation phase, we placed emphasis on the content of the idea cards, for the idea connection and idea improvement phase, we focused on group discourse. The focus group's interactions were audio- and video-recorded, and transcribed for discourse analysis.

<Table 1> Overview of qualitative data sources

Phases	Main Data Sources
Idea generation	Idea cards
Idea connection	Group discourse
Idea improvement	Idea cards & Group discourse
Rise above	Idea cards

To identify the indicators of discourse moves towards collective knowledge advancement, we first divided the corpus of discourse according to the four knowledge-building phases (i.e., idea generation, idea connection, idea improvement and rise-above), based on the timestamp in the transcribed discourse and colors of idea cards. Determining ideas generated in the first phase was relatively straightforward in that we only needed to count yellow-colored idea cards. As for idea connection, two different data sources were collected to evaluate students' performance; that is, group interaction discourse and group presentation. During idea improvement, postings on pink idea cards and group conversation emerged as main data sources. In the final rise-above stage, orange-colored idea cards and group presentation were analyzed.

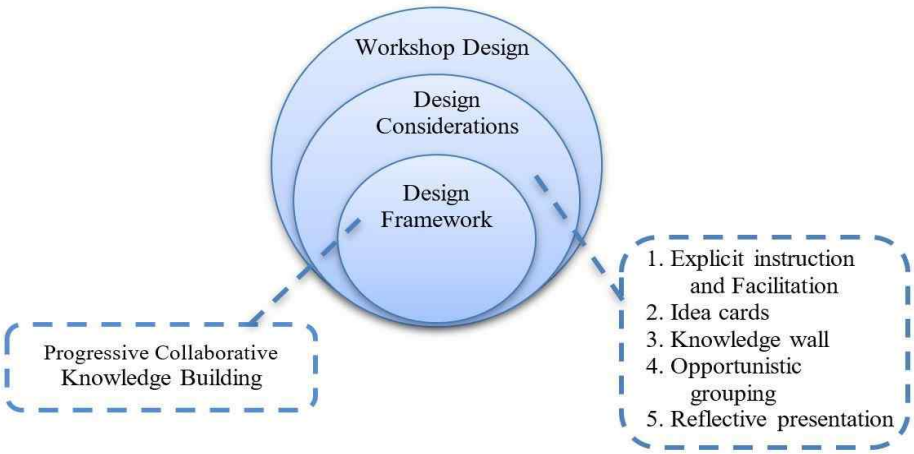
To analyze discourse data, we extracted dialogic segments containing students' intention of including or excluding certain ideas at a sentence level. Then, we coded dialogic segments into "inquiry threads", which are defined "as a series of notes that address a shared principal problem and constitute a conceptual stream in a community knowledge space" (Zhang et al., 2007, p. 125). Inquiry threads were identified by reading through all the transcribed data generated in the idea generation stage, and next, by tracing specific problems pursued by the group members. To ensure the credibility in qualitative data analysis, we adopted a continuous contrast/comparisons method where discourse data was iteratively examined and re-examined according to the main inquiry themes.

Ⅳ. Collaborative Knowledge Building Workshop

1. Overall Structure

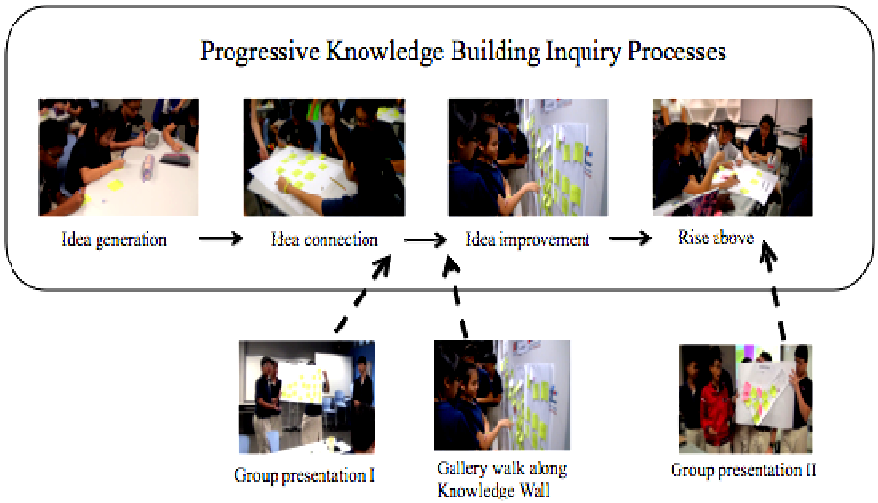
Largely, our workshop design was a combination of both explicit instruction and guided approach. [Figure 1] visualizes the core components of the overall workshop design. The first step was to determine an overarching design framework that foregrounds the theoretical underpinnings of the Knowledge Building Pedagogy in workshop design. While we adopted knowledge building as an overarching theoretical framework, it was challenging to communicate all 12 knowledge building principles to the students due to their theoretical abstractness. Instead, we adopted the 'Progressive Knowledge Building Inquiry Cycle Model' (So et al., 2010), namely *idea generation*, *idea connection*, *idea improvement*, and

rise-above as the key principles and process skills that students need to understand and practice in explicit ways. The cycle was adapted from the 'Model of Progressive Inquiry' (Muukkonen, Hakkarainen, & Lakkala, 1999) that characterizes "the sustained processes of advancing and building of knowledge characteristic to scientific inquiry" (p. 407). The cycle also represents the key components of knowledge building principles such as the importance of improvable ideas, idea diversity, and rise-above.



[Figure 1] Overall structure of the workshop design

<Table 2> presents the brief descriptions of the workshop design. Overall, the workshop was designed with a focus on the four phases of the progressive knowledge building cycle as depicted in [Figure 2]. The first session consists of idea generation and idea connection, after which, the presentation session follows where students summarize their group work and share at the plenary level. In the second session on the following day, all idea cards generated in the first day were grouped into different inquiry threads based on common foci across ideas. Next, students were supposed to choose one inquiry thread according to their interests after the 10 minutes' gallery walk of the knowledge wall. Those with the same interests formed a group to proceed to the next two phases of knowledge building, namely idea connection and idea generation.



[Figure 2] Illustration of knowledge building inquiry processes

<Table 2> Brief descriptions of workshop design

Phases	Activity
DAY I	
Tune-in	Facilitator introduces the progressive knowledge building inquiry cycle & the learning scenario "Early Explorers & Food Matters"
Idea Generation	Students generate ideas and develop own line of inquiries on idea cards using given scaffolds(i.e., "My idea is…"/ "I need to understand…")
Idea Connection	Students compare and contrast own ideas with other students' ideas on the Knowledge Wall for idea connection.
	Presentation & Sharing
DAY II	
Tune-in	Students view inquiry threads of ideas(e.g., nutrition, survival, etc.) on the Knowledge Wall. *Opportunities grouping:* Students form new groups based on common interests for idea improvement.
Idea Improvement	Students in new groups conduct further research. Students reflect on how new information help them improve their initial ideas and write improved ideas using given scaffolds (i.e., "A better idea is … / My new question is …").
Rise-above	Students pull ideas together to come up with high-level statements; summarize what has been learned; state any new concept/ theory/synthesis.
	Presentation & Wrap-up

An important step in the workshop design is to create a problem space for students to practice CKB skills for collective knowledge advancement. This is, the workshop did not merely introduce students with abstract theories and conceptual frameworks, but combined KB principles with concrete activities and tasks to create a space for students to practice in authentic contexts. Teachers and researchers co-created the learning scenario called "Early explorers and food matters" where students assumed a role of an explorer to an unknown island:

- Scenario: Imagine you are an explorer. Your team is tasked to explore an UNKNOWN island for possible human civilization. You do not know "what" lives there or how long you will be there.
- Task: List the types of food that can be taken on this trip, as well as, the storage and preservation of these food items during the exploration. (Give reasons for the list of food you will be taking)

2. Core Design Considerations

As we wanted the activities to embody the knowledge building process, several material and structural conditions coupled with explicit instruction were embedded in the workshop design. We explain five core design considerations in detail below: 1) explicit instruction and facilitation, 2) idea cards, 3) knowledge wall, 4) opportunistic grouping, and 5) reflective presentation.

2.1. Explicit Instruction and Facilitation

The workshop employed an explicit instructional approach to address students' problems of insufficient knowledge building capabilities. Explicit instruction includes various elements like breaking down complex skills and strategies into smaller instructional units, designing organized and focused lessons and providing step-by-step demonstrations. In explicit instruction for teaching novice learners, the role of human facilitation cannot be neglected, as Chai et al. (2011) put it, "fostering collaborative learning among students requires skillful facilitation from teachers who are knowledgeable about many aspects of collaborative learning" (p. 7). Facilitators play a significant role in stimulating students to integrate their prior knowledge with new knowledge in the tasks that they are engaged in. Hmelo-Silver and Barrows (2008) describe an 'expert facilitator' as someone who

would "use a variety of questioning tactics to help support this knowledge-building discourse" and push students to "explain their thinking" and "problematize their ideas" (p. 90). In our workshop, as teachers were relatively new to the knowledge building pedagogy, four researchers with extensive research experiences in a knowledge building pedagogy acted as expert facilitators to provide necessary guidance throughout the workshop process. In addition, the facilitator provided students with explicit instruction about the key principles and process skills of collaborative knowledge building on the first day of the workshop.

2.2. Idea Cards

Students used 'Idea Cards' with textual scaffolds designed to guide students through the knowledge building processes similar to Knowledge Forum. Idea cards are equivalent to notes in Knowledge Forum. With the use of idea cards as physical artifacts, we wanted students to easily see how ideas are shared, connected, can be moved around and improved with artefacts. Bielaczyc and Ow (2010) suggest that idea cards can serve as a dialogic tool to help students learning to make knowledge building moves in concrete ways. In their study, students were able to engage with ideas cards that serve as resources for improving each other's understanding.

Idea cards include textual scaffolds that "are designed to encourage students to engage in expert-like processing of knowledge; they help to move beyond simple question-answer discussion and elicit practices of progressive inquiry" (Muukkonen et al., 1999, p. 410). Different textual scaffolds were embedded in different stages. Semi-structured scaffolds in the form of sentence openers such as "My idea is" and "I need to understand (INTU)" were provided in idea cards used at an idea generation stage, while at idea improvement and rise-above stages, students were supposed to use different scaffolds, "A better idea is", "My new question is" and "New Information is". Three different colors of idea cards were used to indicate different phases of CKB process: yellow cards representing ideas generated during the first stage, pink cards representing improved ideas and orange cards for rise-above ideas. During idea connection and rise-above stages, students were asked to connect ideas by reading all the cards posted on the knowledge wall, drawing a line with a pencil to link similar ideas, and to write new ideas to respond to other ideas. Students were also guided to search on the Internet to find

authoritative sources to support and improve their ideas.

2.3. Knowledge Wall

In the workshop, instead of using a technological platform such as Knowledge Forum (Scardamalia, 2004), we employed a non-technological communal space called Knowledge Wall where individual ideas are made public to community members. The purpose of the knowledge wall is to help students easily share ideas in a public space. The concept of Knowledge Wall has been applied in several knowledge building research to model knowledge creation discourse in a face-to-face situation (Bielaczye & Ow, 2010; Hume, 2001; van Aalst & Truong, 2011; Wells, 2002). For instance, the classroom-based research by Hume (2001) and Bielaczye and Ow (2010) show that the knowledge wall is useful particularly under situations when both teachers and students are new to the knowledge building pedagogy and when the school infrastructure do not support easy access to Knowledge Forum and computer labs. Similarly, van Aalst and Truong (2011) found in their research in the Hong Kong classroom that the knowledge wall made a great contribution to the creation of the classroom ethos where students were not afraid of taking risk of making their ideas visible in a public space, thereby creating a high-level of interest and engagement among students in idea-focused classroom discourse. This was a dramatic contrast to the IRE (Initiate-Response-Evaluate) discourse pattern prevalent in many Asian classrooms where teachers lead the question and answer session.

2.4. Opportunistic Grouping

There has been much discussion about how students should be grouped for productive collaboration. In this workshop, we adopted opportunistic grouping during the idea improvement and rise-above stages, by encouraging students to freely choose their areas of interest after going through all the postings on the knowledge wall. Opportunistic grouping refers to a form of grouping where students are flexible to form, disband, and recombine group members based on their common interests or goals that emerge during collaboration. The conception of opportunistic collaboration emerged from the research on knowledge innovation that highlights the criticality of an organic, flexile structure for a high degree of

adaptability, fluidity and emergence of ideas (Gloor, 2005). Zhang et al. (2009) found that opportunistic collaboration, when compared with fixed-group and interacting group collaboration, could give rise to "more pervasive, flexible, distributed collaborations, and greater diffusion of information and knowledge advances" (p. 34). They argue that the flexible and opportunistic design can help students better monitor gaps in the community knowledge space and have more control and responsibility in their own participation for collective knowledge advancement.

2.5. Reflective Presentation

The last key consideration in the workshop design was to position group presentation as a tool for metacognitive reflective thinking. Group presentation, as a technique of reflection, is "an integral element of metacognition as it is the means by which one monitors thinking processes" (Kriewaldt, 2001, p. 3). Reflective presentation has been used in several fields where post-reflection on the process of action and thinking is important to improve skills. In the knowledge building research, it is of high importance to embed opportunities for "metacognitive reflective thinking" in the whole inquiry cycle to make students reflect on the process of knowledge building as well as generated ideas. During the group presentation, we asked students to intentionally reflect on the nature of their participation in collaboration process and the ways in which ideas were discussed and built, such as how they dealt with multiple ideas for agreements and disagreements and how they reached final consensus during idea connection and rise-above phases.

V. Findings

1. Student Perception Data

The survey instrument was administered via an online form after the two-day workshop. As the participation was not mandatory, 17 students (5 females, 12 males) completed all the responses in the survey. <Table 3> presents the descriptive statistics of the survey responses. On the whole, we found that students' perceptions towards the workshop are positive with all the mean values

above 4.0, expect one item statement 'Members of the team encouraged all others to participate' (M=3.88) under the construct 'team work'. The highest rated statement in the survey is 'Everyone on my team contributed to the success of the group tasks' (M=4.35) in the category of perceptions of team members. Among the four constructs, the mean score of perceptions of team members' was the highest (M=4.30), while the mean score of team work was the lowest (M=4.09).

<Table 3> Descriptive statistics on students' perceptions about CKB activities (N=17)

Self-Perceptions	Mean	SD
1. I participated in the team activities related to the group tasks.	4.12	.32
2. I contributed to the team discussions related to the group tasks.	4.29	.46
3. I communicated with members of my team concerning the group tasks.	4.23	.42
Sub-total	4.22	.42
Perception of Team Members		
4. Everyone showed respect.	4.29	.46
5. Everyone on my team contributed to the success of the group tasks.	4.35	.48
6. Everyone on my team contributed to solve problems.	4.41	.49
7. My team worked well together.	4.29	.75
8. My team members communicated well.	4.18	.51
Sub-total	4.30	.56
Team Work		
9. I cooperated with all team members.	4.24	.42
10. Team members felt free to express opinions.	4.18	.62
11. My group considered and discussed all ideas presented by team members.	4.00	.49
12. Everyone listened with an open mind.	4.06	.49
13. Members of the team encouraged all others to participate.	3.88	.83
14. Team members worked together to solve problems.	4.24	.42
15. No one dominates the team discussions and decisions.	4.06	.64
16. My group needed the equal contribution of all members to produce the best findings for the group tasks.	4.18	.51
17. My group members contributed equally in our collaborative project.	4.06	.64
18. My team implemented the recommendations from all group members into the group tasks.	4.06	.42
Sub-total	4.09	.58
Progress		
19. My team solved problems well.	4.06	.42
20. My team worked efficiently most of the time.	4.24	.42
21. We achieved more as a group than we would have working individually.	4.18	.71

Sub-total	4.16	.54
Satisfaction		
22. There was sufficient individual accountability in the group tasks.	4.00	.49
23. I have benefited from the collaborative knowledge building experience in the workshop.	4.18	.38
24. I have benefited from the collaborative knowledge building experience in the workshop.	4.12	.58
25. Working with my team has been a positive experience.	4.29	.46
26. I look forward to working with my team.	4.00	.69
27. The group tasks promoted creativity.	4.00	.77
28. It is easier to complete the activities when working with a group.	4.18	.58
Sub-total	4.10	.59

2. Group Discourse Data

While the survey data was useful to evaluate the overall student perception about their experiences in and satisfaction with the collaborative knowledge building process during the workshop, it did not provide in-depth information about how the groups actually collaborated to solve the given problem scenario 'Early explorers and food matters'. Hence, we followed one focus group throughout the workshop to examine how knowledge building discourse emerged during the group work. In this paper, due to the space constraint we use one inquiry thread called "Preservation and Nutrition" to illustrate and discuss how the group showed indicators of collaborative knowledge building in relation to the principle of improvable ideas and the use of authoritative sources. In this thread, the group generated ideas about how much of food a person needs for survival (see Tables 4 & 5).

2.1. Improvable Ideas

Central to the knowledge building pedagogy is that students need to perceive that ideas are not fixed, but improvable. We facilitated the process of improving ideas through the use of textual scaffolding in the idea cards. <Table 4> presents some examples about how the group members used the textual scaffolds in each phase of the progressive knowledge building inquiry cycle. During the idea generation and idea improvement phases, the analysis of students' postings on idea cards shows that scaffolding such as "I need to understand…", "A better idea i s…" and "New Information is…" have assisted students to become aware of the steps in the knowledge building process. It was interesting to see that students

continued to use such sentence openers during group discussion even though they were not referring to idea cards.

During the idea connection phase, the students in the focus group came together to share their own ideas within the group and to connect similar ideas together. The primary data source for observing students' efforts to connect ideas was group verbal interaction in which they discussed similarity and/or incompatibility of ideas generated at the first stage. When students read similar ideas on the Mahjong paper, they displayed awareness about idea connection by using statements such as "I link everything" and "we can draw a line" to compare and contrast multiple ideas. In addition, group presentations reveal the groups' reflective thinking about the underlying reasons for generating and grouping ideas, by saying that "One of our groups' ideas and inquiries was we actually put all the ideas and inquiries regarding dried food all together", and continued to explain the reasons for grouping certain ideas together based on the commonality for easy preservation of food.

<Table 4> Overview of progressive idea improvement with scaffolding

Phases	Ideas
Idea generation	• *I need to ensure* a balanced energy level and/or calories, etc. for every meal. • *My idea* is to bring food that is more solid (not liquid based). This is to minimize the spillage of liquid based food. For example: potato. • *My idea* is to bring dry foodstuff because they do not need cooking and they can be eaten anytime, when needed.
Idea connection	• Did you see anything related to canned food? • Yeah, it is almost the same. So it's related. • It's not related to this. • We can draw a line.
Idea improvement	• *A better idea* would be to bring light food that is nutritious and easy to cook/prepare, e.g. instant noodles. A new question would be how much nutrients an average person needs daily. • *New information* is that an average person needs about 2000 calories a day. • *New information*: a packet of instant noodles carries about 222 calories.
Rise above	• *Summary of learning points*: I learn that not all food is nutritious and convenient, so we must try to find more of them. • *Problem areas & specific knowledge advances*: We thought instant noodles were nutritious but only some were so. We need to find out the ones that are nutritious.

2.2. Refining Ideas and Rise Above

In the process of improving ideas around the inquiry thread "Preservation and Nutrition", we could notice how they struggled to solve their divergent ideas and finally reached a consensus. One key question that triggered much discussion among the group members is "how much a person needs to bring food for survival". <Table 5> shows discourse moves in this sub-inquiry thread. Students seemed to exhibit a tendency to arrive at quick consensus, rather than, explore other potential ideas. As evident in conflict and repairs, as well as inquiry clarification and negotiation (see Table 5), students did not fully leverage on one another's ideas/contributions to delve deeper to open issues and questionable ideas. At the beginning, group members were unsure about how to improve the existing ideas collectively; instead, they thought that they were supposed to write their own ideas individually without group discussion. This tendency to quickly reach a consensus needed some guidance from the facilitators who encouraged the group to explore additional information beyond what they already know. This prompted the group searched the Internet and found the new information that "an average person needs about 2000 calories per day". However, the expert resources here were presented by merely providing an excerpt of online information, which can be labeled as introducing resources rather than going beyond resource material (Zhang et al., 2007, p, 135). That is, the group did not make any critical evaluation about the validity of the new information. The idea to seeking for additional information to go beyond resource materials ("Do we need more new information?) was not taken up.

<Table 5> Overview of progressive problem solving process

Discourse Moves	
Question-initialization	How much should a person bring potentially?
Question-Refinement	It should be how much a person needs.
Information-seeking	The average man can carry about 10kg.
Conflict and repairs	Yes, but you don't need to carry 10 kg; you only need to carry how much you need.
Question-Refinement	How many of let's say this thing can roughly pack in order to like survive for the adventure trip.
Inquiry-clarification and negotiation	How much nutrients does an average person need in order to let's say just … meet his daily needs…based on metabolism.

Information-seeking	1. We need new information. Can just research on how much does an average person … consume. 2. [*after the Internet search*] An average person needs about 2000 calories. Average. 3. The average person needs about. Should I choose the bigger number or the smaller number? About 60 grams of fat.
Inquiry-clarification	Do we need more new information?
Idea convergence	1. We need to do this (referring to 'fat')? 2. No. We must write the calories, write in calories form

Ⅵ. Discussion and Conclusion

This paper reports the design, enactment, and evaluation of the workshop that aimed to help students experience the cycle of collaborative knowledge building. In the workshop design, we integrated both explicit instruction and imbedded approaches to help students learning to collaboratively build knowledge. We posit that both explicit instruction and guided approaches can be integrated to cultivate a knowledge-creating culture in a situation where both teachers and students are new to the knowledge building pedagogy. By examining students' perception and discourse data, the study reveals that those secondary students were receptive to facilitator's guidance and instructions, which can be seen from the overall positive perception about collaborative learning experiences in the workshop and the indicators of knowledge building discourse moves in the group discussion. However, the students still needed more guidance in the process of teamwork, particularly in consensus building, as seen in the tendency to reach a quick consensus.

This study provides some critical implications to researchers and educators who have similar goals to help students learning to collaborate in the context of knowledge building. First, we suggest that when both students and teachers lack necessary social and cognitive practices consistent with knowledge building, it is useful to make the principles and process of knowledge building explicit to students through explicit approaches, and thereafter, monitor their progress and adapt the scaffolds to help them improve their skills in the Knowledge Forum online platform. We propose that during students'initial stages of knowledge building, they can firstly go through the transitional stage in a non-technological

space to understand theoretical principles of knowledge building and make a gradual transition to a higher-level stage in a technological platform where they need to flexibly exercise knowledge building practices. This approach will be particularly useful when the school infrastructure does not allow easy access to computers. Additionally, we believe that the use of idea cards and knowledge wall as illustrated in this paper can function as a mechanism for epistemological perturbations (Ow & Bielaczyc, 2007) that students use material artefacts to learn to make knowledge building moves in a collaborative manner.

Second, we believe that explicit instruction and facilitation coupled with appropriate activity design can help students familiarize with knowledge building principles. However, it should be cautious that the densely structured facilitation might restrict students' agency for idea improvement (i.e., signs of students' dependency on facilitator's guidance), as students may see knowledge building processes as standardized operations. The principle of epistemic agency should be supported through adaptive guidance to help students become aware of their own learning process and exercise self-reflection rather than merely following the given scaffoldings.

Albeit that the study discussed detailed workshop design process and revealed some encouraging findings that might be informative for researchers and practitioners to conduct such workshops, it has some limitations. The first limitation is related to time duration on skill training. The conditions for performing knowledge building activities/ tasks differ from that of procedural tasks, as knowledge building activity types cannot be thoroughly dealt with within two-sessions of the workshop and students need longer time to digest and practice the skill sets. The second limitation is that our data sources are confined to the workshop, and we did not examine how the students transferred the knowledge and skills learned in the workshop to the subsequent lessons after the introduction of Knowledge Forum. While we did not present data about sustained effects in this paper, another study with teacher narrative data showed that teachers observed the occurrence of knowledge building discourse in both offline and online interaction (in Knowledge Forum), which is a promising indication of the enculturation process. Since this study was conducted in the context of a future school where the socio-technological infrastructure was conducive for fostering a knowledge building culture, generalizing any findings to other research contexts should be done with caution.

In a nutshell, while we do not argue that the students were able to fully grasp the skills of collaborative knowledge construction within such a short period of time, from a holistic perspective, their performance did display some indicators of understanding and applying the key principles of knowledge building. This study makes some contributions to the literature on the learner-centered pedagogy in the Asia-Pacific education context by highlighting the necessity about helping students learn to collaborate, with the illustration of the design, enactment and evaluation of the collaborative knowledge building workshop. In our future study, we shall further investigate whether students have acquired and sustained the essence of progressive knowledge building inquiry practices through engaging students in authentic learning tasks.

References

Archer, A. L., & Hughes, C. A. (2011). *Explicit instruction: Effective and efficient teaching*. New York, NY: Guilford Press.

Bielaczye, K., & Ow, J. (2010, June). Making knowledge building moves: toward cultivating knowledge building communities in classrooms. *In Proceedings of the 9th International Conference of the Learning Sciences-Volume 1* (pp. 865-872). International Society of the Learning Sciences.

Brown, L. A., Eastham, N. P., & Ku, H. Y. (2006). A performance evaluation of the collaborative efforts in an online group research project. *Performance Improvement Quarterly, 19*(3), 121-140.

Chai, C. S., Lim, W. Y., So, H. J., & Cheah, H. M. (2011). *Advancing collaborative learning with ICT: Conception, cases and design*. Educational Technology Division: Ministry of Education Singapore. Retrieved on August 20, 2016 from http://ictconnection.edumall.sg/ictconnection/slot/u200/mp3/monographs/advancing%20collaborative

Chan, C. K. (2011). Bridging research and practice: Implementing and sustaining knowledge building in Hong Kong classrooms. *International Journal of Computer-Supported Collaborative Learning, 6*(2), 147-186.

Cortez, C., Nussbaum, M., Woywood, G., & Aravena, R. (2009). Learning to collaborate by collaborating: a face to face collaborative activity for measuring and learning basics about teamwork1. *Journal of Computer Assisted Learning, 25*(2), 126-142.

Dillenbourg, P. (2002). Over-scripting CSCL: The risks of blending collaborative learning with instructional design. In P. A. Kirschner (Ed.), *Three worlds of CSCL. Can we support CSCL?* (pp. 61-91). Heerlen: Open Universiteit.

Gillies, R. M. (2003). Structuring cooperative group work in classrooms. *International Journal of Educational Research, 39*(1), 35-49.

Gillies, R. M., & Ashman, A. F. (1996). Teaching collaborative skills to primary school children in classroom-based work groups. *Learning and Instruction, 6*(3), 187-200.

Gloor, P. A. (2005). *Swarm creativity: Competitive advantage through collaborative innovation networks*. Oxford: Oxford University Press.

Hmelo-Silver, C. E., & Barrows, H. S. (2008). Facilitating collaborative knowledge building. *Cognition and Instruction, 26*(1), 48-94.

Hume, K. (2001). Seeing shades of gray: Developing a knowledge-building community through science. In G. Wells (Ed.), *Action, talk, and text: Learning and teaching through inquiry* (pp. 99-117). New York: Teachers College Press.

Johnson, D. W., & Johnson, R. T. (1989). *Cooperation and competition: Theory and research.* Edina, MN: Interaction Book Company.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(2), 75-86.

Kriewaldt, J. (2001). A thinking geography curriculum. *Interaction, 29*(4), 1-7.

Lee, E. Y., Chan, C. K., & van Aalst, J. (2006). Students assessing their own collaborative knowledge building. *International Journal of Computer-Supported Collaborative Learning, 1*(1), 57-87.

Muukkonen, H., Hakkarainen, K., & Lakkala, M. (1999). Collaborative technology for facilitating progressive inquiry: Future learning environment tools. *In Proceedings of the conference on Computer support for collaborative learning* (pp. 406-415). International Society of the Learning Sciences.

O'Donnell, A. M. (1999). Structuring dyadic interaction through scripted cooperation. Cognitive perspectives on peer learning. In A. M. O'Donell & A. King (Eds.), *Cognitive perspectives on peer learning* (pp. 179-196). Mahwah, NJ: Erlbaum.

Oshima, J., Oshima, R., Murayama, I., Inagaki, S., Takenaka, M., Yamamoto, T., . . . Nakayama, H. (2006). Knowledge-building activity structures in Japanese elementary science pedagogy. *International Journal of Computer-Supported Collaborative Learning, 1*(2), 229-246.

Ow, J., & Bielaczyc, K. (2007). Epistemological perturbations: using material artifacts to cultivate a knowledge building culture in classrooms. *In proceedings of the 8th International conference on Computer supported collaborative learning* (pp. 583-585). International Society of the Learning Sciences.

Rummel, N., & Spada, H. (2005). Learning to collaborate: An instructional approach to promoting collaborative problem solving in computer-mediated settings. *The Journal of the Learning Sciences, 14*(2), 201-241.

Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of

knowledge. In B. Smith (Ed.), *Liberal education in a knowledge society* (pp. 67-98). Chicago: Open Court.

Scardamalia, M. (2004). CSILE/Knowledge forum®. In A. Kovalchick & K. Dawson (Eds.), *Education and technology: An encyclopedia* (pp. 183-192). Santa Barbara: ABC-CLIO.

Scardamalia, M., & Bereiter, C. (2003). Knowledge building. In J. W. Guthric (Ed.), *Encyclopedia of education* (2nd ed., pp. 1370-1373). New York: Macmillan Reference USA.

Scardamalia, M., & Bereiter, C. (2006). Knowledge building. In K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 97-118). New York: Cambridge University Press.

So, H.-J., Seah, L. H., & Toh-Heng, H. L. (2010). Designing collaborative knowledge building environments accessible to all learners: Impacts and design challenges. *Computers & Education, 54*(2), 479-490.

So, H.-J., Tan, E. B. K., & Tay, J. (2012). Collaborative mobile learning in situ from knowledge building perspectives. *The Asia Pacific Education Researcher, 21*(1), 51-62.

van Aalst, J., & Truong, M. S. (2011). Promoting knowledge creation discourse in an Asian primary five classroom: Results from an inquiry into life cycles. *International Journal of Science Education, 33*(4), 487-515.

Weinberger, A., & Fischer, F. (2006). A framework to analyze argumentative knowledge construction in computer-supported collaborative learning. *Computers & Education, 46*(1), 71-95.

Wells, G. (2002). Learning and teaching for understanding: The key role of collaborative knowledge building. In J. Brophy (Ed.), *Social constructivist teaching: Affordances and constraints* (Vol. 9, pp. 1-41): Emerald Group Publishing Limited.

White, B. Y., & Frederiksen, J. R. (1998). Inquiry, modeling, and metacognition: Making science accessible to all students. *Cognition and Instruction, 16*(1), 3-118.

Zhang, J., Hong, H.-Y., Scardamalia, M., Teo, C. L., & Morley, E. A. (2011). Sustaining knowledge building as a principle-based innovation at an elementary school. *The Journal of the Learning Sciences, 20*(2), 262-307.

Zhang, J., Scardamalia, M., Lamon, M., Messina, R., & Reeve, R. (2007). Socio-cognitive dynamics of knowledge building in the work of 9-and

10-year-olds. *Educational Technology Research & Development, 55*(2), 117-145.

Zhang, J., Scardamalia, M., Reeve, R., & Messina, R. (2009). Designs for collective cognitive responsibility in knowledge-building communities. *The Journal of the Learning Sciences, 18*(1), 7-44.

논문 접수: 2016년 8월 31일
논문 심사: 2016년 9월 18일
게재 승인: 2016년 10월 4일

<국문초록>

싱가포르 미래학교의 협동적 지식형성 학습 사례

소효정(이화여자대학교)
Xujuan Zhang(First High School of Changsha County)
Esther Tan(Open University of the Netherlands)

본 연구는 아시아 학생들이 협동적 지식 책무성의 기술과 이해가 부족하다는 점을 인식하고, 해당 문제 해결을 위한 협동적 지식 형성 워크숍의 설계부터 실행 및 평가에 이르는 일련의 과정을 실천적 사례로 소개하고자 한다. 본 연구는 싱가포르의 미래학교 중 하나인 중학교의 13세 학생들을 대상으로 실시되었다. 학생들은 협동적 지식형성에 대한 명시적 수업뿐만 아니라, 아이디어 카드, 지식의 벽, 기회적 그룹 형성, 성찰적 발표 등의 물리적 구조적 조건이 배치된 워크숍에 참여하였다. 평가를 위해서 학생들은 워크숍후에 협동학습 태도에 관한 설문지에 응답하였으며, 한 특정 그룹의 협동학습 과정에 대한 담화분석도 실시하였다. 연구 결과 학생들이 워크숍에서 경험한 협동적 학습에 대해 긍정적 인식을 가지고 있으며, 그룹 담화분석에서는 지식형성 담화의 특성이 발견되었다. 하지만, 학생들은 여전히 팀워크 과정에 관해 더 많은 안내를 필요로 하였고, 특히 협동적 지식형성 과정에서 단시간에 합의에 이르려고 하는 경향이 문제점으로 발견되었다.

★ **주제어: 지식형성, 협동학습, 협동적 인지 책무성**