Understanding Teacher’s Principle-Based Practice in Sustaining Knowledge Building Practice in a Science Classroom

Mohd Noor Hishamuddin Haslir, Ping Yi Secondary School, Mohd_noor_hishamuddin_haslir@moe.edu.sg
Teo Chew Lee, Ministry of Education, Singapore, Teo_chew_lee@moe.gov.sg
Shahizha Bte Mohd, Ping Yi Secondary School, Shahizah_Mohd@moe.edu.sg
Lee Yu Ling, Ministry of Education, Singapore, yuling.lee22@gmail.com

Abstract: In this paper, we trace one teacher’s attempt to design knowledge building classroom in a principled way for a class of low achievers. Through the narrative of teacher’s effort in planning, enacting, and reflecting on knowledge building practice, we hope to provide a perspective for practitioners to construct 21st century teaching and design capability. Understanding teachers’ work in their natural setting is important in encouraging a culture of learning designers among teachers; one that centers around students’ thinking and learning more than teachers’ judgment. Such a principle-based approach relies on teachers’ interpretation of Knowledge Building principles and their translation of these principles into daily practice. As the idea of teachers as designers of learning is rather under-represented in practice, we hope such reflective journeys will provide a lens to other practitioners and challenge the notion that such a principled-based approach is only theoretically sound and has little practical value.

Introduction
There has been a significant effort to shift from individual inquiry to collaborative inquiry in educational approaches so that student learning remains vibrant and robust, thus ensuring that they are ready to face the challenges in this world of rapid change and technological advancement (Scardamalia & Bereiter, 2006). Although the ‘why’ of the shift is clear, many teachers still grapple with the ‘how’. In recent years, we have seen an extensive professional development effort aiming to prepare teachers to embrace such a shift while continuing to be efficient and effective in their work. In this paper, we trace one teacher’s attempt to reflect and design knowledge building practice in a principled way in a class of lower ability Science students. Through the narrative of teacher’s planning, enacting and reflecting, we hope to provide a glimpse into 21st century teaching competencies and ways to develop teachers’ design capability.

Teachers’ role in a KB classroom
KB practice involves teachers making decisions that move towards fostering and sustaining a knowledge creation culture that supports creative work and continual improvement of ideas. Teachers have to think about the kind of interactions in their classes that puts students’ ideas at the center of the classroom enterprise (Scardamalia & Bereiter, 2003). Teachers also have to rationalize and translate their teaching practice in relation to Knowledge Building principles (Scardamalia, 2002) which characterize an interactive system that makes continual improvement of ideas possible. Apart from these efforts directly relating to translating KB principles, teachers also have to adapt teaching strategies according to their students’ diverse needs and academic backgrounds, and provide students with sufficient guidance to engage their heart and mind in knowledge building processes (So, Seah & Toh-Heng, 2010).

Knowledge building in a science classroom
Many studies have undertaken the task of implementing knowledge building approach in the teaching and learning of science topics. Research has demonstrated that students of all ages can work as knowledge builders, e.g., when students are given opportunities to attempt problems of understanding that they are interested to explore, they are able to work through the problems to derive good explanations. All of which characterises deeper inquiry in science (Zhang et al., 2007; Scardamalia & Bereiter, 2009; Chuy et al., 2010). Although research has shown that knowledge building pedagogy benefits both high- and low-achieving students (So et al., 2010, Niu & van Aalst, 2005; and Chan & Lee, 2007; So et al., 2010), there still exists a general belief that low ability students do not have the cognitive foundation to navigate in such an environment. This misconception of students’ knowledge building ability is generally mirrored in an examination of existing literature on teachers’ beliefs, practices, and competencies.
Narratives of teacher reflecting and designing a KB classroom

This case study traced the work of a teacher who has six years of teaching experience and two years of Knowledge Building experience over a 5-week period. He has been working with Normal Technical (NT) classes for all his years as teacher. These NT students are the lowest scoring cohort in the Primary School Leaving Examination and deemed to be less inclined academically. Their secondary education mainly prepares them for further vocational and technical training at the Institute of Technical Education (ITE). Based on his experience with this group of students, the teacher was initially hesitant about adopting KB approach on the topic of “Food Matter” due to time constraints. However, after he discussed the values of science education with his Head of department and the researcher, he decided to try to prioritize the “developing of thinking about science” (as he put it) rather than the delivery of content in his NT class this year. He felt that this goal matched with that of the KB approach.

Getting started

For the first lesson, the teacher started off by sharing some basic knowledge on the topic on Food, followed by a classroom discussion on the topic. The discussion was done solely in class and captured by the teacher on the whiteboard. This brainstorming on "Food" raised some interesting questions such as "how is food important?" and "how is food made/ created?" With knowledge building principles of real ideas and authentic problems in mind, the teacher was careful not to dictate the content so as to allow students’ ideas to take precedence in the classroom. He later reflected that he was pleasantly surprised that the students already knew quite a bit in the textbook and that they were able to recall the facts from textbook.

Shaping ideas through experiment and discourse

In the second lesson, the teacher felt that more information was needed to develop his students' ideas about food so he introduced a series of experiments on food testing and got students to talk about these experiments. A student managed to connect starch observed in the experiment to their discussion on ‘plant being the largest producer of food’ in the previous lesson. The class subsequently became interested in the growth of plants as a source of food producer. This interest led to a discussion on environment when the idea of soil acidity was introduced. Students verbalized their ideas on acidity in soil and the teacher wrote their ideas on the whiteboard. He then got students to take down notes about the discussion in their own journals. Throughout this, teacher actively modeled note-taking and active-listening. He realized, in retrospect, that “the NT students started to ask question that Express students would not ask”, he described that as his turning point in the way he was determined to design the lessons the knowledge building way.

Extending discourse in class to include online platform

At this point, the first Knowledge Forum (KF) View was created to get students to pose their ideas online instead of simply voicing them out in class. The transition to the online platform was fairly seamless because students were eager to extend their classroom discussions. Thus, students’ ideas came forth quite quickly at this stage.

Figure 1. First Knowledge Forum View for the students.

The teacher explained that since KB teaching method is not one size fit all, different teachers have different styles and different classes have different needs. Based on this thought and as he thought through what has taken place in class so far, the teacher decided to get students to move away from textbooks and express their understanding through journal and notes to complement their idea sharing on KF. Further, to make sure that students are motivated to journal their learning, he decided not to provide additional notes to students and instead,
get them to use their own journal for revision. Hence, throughout these lessons, whenever students asked him for teachers’ notes, he replied that the textbook is sufficient and that they (the students) should be the ones creating their notes for revision.

Redesigning scaffolds to sustaining idea improvement

In planning the third lesson, the teacher noted that the questions posted by students on KF were not good enough as students didn’t understand how to use the scaffolds. He decided to redesign the scaffold to make it more understandable to and accessible by his students. He found a resource online that unpacks the original knowledge building scaffolds into active phrases. For example, this new set of scaffold has four sentence starters; “I think”, “I learn”, “I believe”, “I saw” versus “My theory” in the original KB scaffold and “I wonder why”, “I wonder if”, “I wonder who…what…where…how” replacing “I need to understand”. The new set of scaffolds seemed to work, but the teacher soon realized that students’ questions posted online were quite similar (lack of idea diversity needed for knowledge building). Hence, he decided to give them more time to shape their ideas. He got students to first jot down their ideas in their journals, then read the notes on KF, and subsequently post a different or improved ideas on KF. He also got students to focus on writing meaningful titles for their notes in an effort to get them to think about their post.

In one of the subsequent KF views titled ‘Sources of Food - Concepts’ (refer to Figure 2 below), students posted notes and built on others’ notes while teacher made use of these notes to conduct a class discussion in which students brought up multiple ideas, such as mass production and how cities are made. Students also brought in relevant information on agriculture that they had learned from watching National Geographic.

When one student posted, “I wonder how fertilizer helps plant grow faster” and “how do you improve food production”, the teacher seized this opportunity to start a class discussion about fertilizer. Students responded with a multitude of perspectives on fertilizers, e.g., a danger to health. He then showed the class two sets of videos as resources for students to watch and deepen their understand of the points discussed in class.

The teacher felt that there was a deeper understanding of this topic for the students this time round. Students were particularly interested in the video of slash and burn as Singapore was then undergoing a period of haze caused by such actions in Indonesia. The teacher utilised this interest and got students to research online on the two topics (fertilizer and slash and burn) and the question (“how do you improve food production”), and to post their information gathered on a new KF view titled “Soil Fertility”.

Embedded assessment

Before the final lesson in this series of KB lessons, the teacher worked with the researcher to design questions based on a new scenario of a group of farmers living near volcanoes and got students coming together to reason out the scenario. Students sat in groups of three to reason out the case in Indonesia where farmers continued to stay close to active volcanoes. Many were quoting what they understood about slash and burn, soil, farmers’ needs, etc., to explain the situation. They were also talking about the danger of the lives of farmers as they
rationalized the scenario. Upon reflection, the teacher felt that students were displaying critical and global thinking which was quite rare for this group of students, as seen in their past performances. Results from this exercise showed that the students were able to accurately surface key ideas, pull out information, and even connect information from the various discussions in class and on KF to explain the phenomenon. The explanation might include naive understanding but the teacher reflected that he was surprised at the reasoning the students displayed in their response to the questions which he has not seen before. Below are abstracts of the students’ interview.

**Student 1:** What if their house is not close, but their plant is close. They cut and harvest and it become(s) the new fertilizer. Some volcano has certain timing. The one in Surabaya, the tour guide told me there is a timing every year.

**Student 2:** That maybe the reason because lava is hot, maybe the farmers’ plant needs heat. Oh wait! the smoke is carbon dioxide right? So the plant takes in carbon dioxide and take(s) out oxygen.

**Student 3:** The ash maybe fertilizer, we take like the slash and burn example, those remaining burn parts become the fertilizer. The burn from the slash and burn.

**Rise above**

As a final activity, teacher printed all of students’ notes in the ‘Soil Fertility’ view. He got students to review one or two notes each, then put the notes up on the classroom wall to build a collective whole-class learning artefact based on the overarching theme of ‘yield’. After the activity had been completed, the teacher led an entire class discussion to get students to connect and synthesize ideas.

**Conclusion**

The dynamics of a knowledge building classroom is highly dependent on the interaction between teacher and students. In this study, the teacher’s role was largely that of providing time and space for students to inquire and explore their ideas on KF, and advancing knowledge along with them. He also carried out the critical task of developing lessons which encouraged inquiry processes and supported collaboration amongst students. His lesson design incorporated a principled way of designing a trigger activity (experiments on food testing and soil acidity), and providing opportunities for contribution (creating new KF views and coming up with scaffolds), as well as space for collaboration (classroom discussions to allow students the opportunity to voice their opinions).

**References**


