Using Activity Theory to Understand Qualitative Differences in Principle-Based Innovation of Two KB Teachers

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Introduction

In Singapore, Knowledge Building (KB) is an innovative pedagogy work that is expanding across schools and classrooms with new teachers coming on board the local community of KB teachers in adopting and practicing this pedagogy. In KB, students learn by generating and inquiring into ideas of interest and collectively improve on ideas to deepen community knowledge (Scardamalia & Bereiter, 2006). An online environment called Knowledge Forum (KF) serves as the platform for capturing student idea generation and development. More essentially, KB requires teachers to adopt a principle-based rather than a procedural approach to instruction (Zhang & Scardamalia, 2007). This means that teachers function as "pedagogical knowledge builders" where they innovate activities, instruction and assessment to support community knowledge advancement as opposed to simply being an "implementer" of a set of pre-designed activities and relying on procedural knowledge and carefully guided instruction to support learning (ibid). Supporting teachers in principle-based innovation is a set of KB principles for design and implementation (Table 1). In practice, KB principles should work together to support students in community knowledge advancement. For example, teachers design problems based on *Real Ideas, Authentic Problems*, view student ideas as improvable (*Improvable Ideas*), value every contribution (*Democratic Knowledge*), encourage different perspectives (*Idea Diversity*) and encourage higher formulation of problems (*Rise Above*). Supporting students in this learning process potentially lead to knowledge transforming processes from complex problem solving, and promote creative, higher-order thinking capacity in students (Hong & Sullivan, 2009). However, teachers' instructional practice vary according to context, and understanding how individual teachers view and implement KB as a principle-based innovation can constitute an important aspect for professional development support and sustaining the work and culture of KB in schools. In this paper, we attempt to gain insights into KB teachers' practice in Singapore classrooms and to examine the extent of principle-based innovation in practice. To support this work, we draw on activity theory as an analytical lens to explore how teachers interact across the different elements of KB work.

Activity theory

Activity theory is a socio-cultural framework to understand goal-oriented, collective, and culturally mediated human activity. An activity system informs how the subject negotiate meaning in relation to the environment. An activity system is represented by six interrelated components (Figure 1): subject, objects, mediating artifacts, rules, community and the division of labor (Engeström, 2001). Subject refers to an individual or a group. Objects refer to the goals or objectives that lead to outcomes. Mediating artifacts are tools used by the subject to achieve their goals, while rules include regulations or procedures for activity. Community refers to social groups with which the subject identified while participating in the activity. Division of Labor (DoL) refers to how the tasks are shared among the community. In this paper, we use

activity theory to study how teachers interact with i) the goals of KB activity in classrooms, ii) the mediating tools and rules of engagement for KB, and iii) the DoL to support KB.

Methodology

We employed a qualitative case study to gain an in-depth understanding on teachers' practice (Yin, 2011). Our study focused on two teachers who taught the same class. Tim is an experienced science teacher but new to KB. Alex, a social studies teacher, started KB work about 3 years ago. The students were in the gifted education programme (GEP). Data included lesson observations, teacher interviews and students' discussion from KF, obtained from September 2018 to March 2019. Tim taught two science topics: i) Cycles in plant system where he introduced a phenomenon called Colony Collapse Disorder (CCD) to generate student discussion in KF and ii) Electricity where he setup different torchlight scenarios to generate student discussion about the problems in KF. Alex taught one topic where he designed a legal trial scenario for judging Emperor Qin to generate student discussion on KF. The teachers' activity systems was analysed based on interview transcripts supported by lesson observations and student notes in KF.

Results

Our analyses show qualitative differences reflected in their object of activity, tool use, teacher facilitation and DoL for principle-based innovation (Table 2). In terms of outcomes and object of activity, Tim mainly intended KB for idea sharing among students in order to develop their communication skills and to enhance factual learning. This was evident from his goals of students learning key curriculum words and explanation and sharing different ideas when solving the problems in KB. His goals reflected little intention of student reasoning and community knowledge advancement. Quite differently, Alex identified idea improvement and community knowledge advancement from KB to promote thinking and reasoning as important learning outcome from KB. As shown in Table 2, Alex's goals reflected his aims for students to acquire deeper understanding of issue through idea improvement and to improve thinking through reasoning and promising ideas.

Different extent of principle-based approach also manifested in their tool use and KB facilitation. Tim, for example, utilized KF as a collaboration tool for students to generate solutions to problems or to surface out misconceptions. Hence, he mainly intended KF to promote idea sharing. Although Tim attempted to use learning analytics, his intention was to promote right answers. For example, his use of scaffold analytics emphasized factual knowledge from explanations.

> "… "I can add on this point". They should use that scaffold. So for example why they choose the parallel circuit, some will say that it's brighter but there are more reasons than this. So they can use "I can add on this point" then they can think of other reasons: I can control the bulb independently, if one bulb fuse, the other bulb still can light up. So the scaffold I thought it's important. And sometimes I will tell them explicitly."

Such an emphasis on factual learning was also evident from the way he facilitated the rules of learning. Mainly, his approach of assessing or evaluating ideas guided students towards prescribed answers from the syllabus. For example, from his reflection, he said:

> "I think some give very good answer. Like today one I look at the parallel/series view. Some give me the perfect answer. No need to add on anything. Whereas some, out of 3 points, they only have 1 point." (Tim)

> "I told them primary school the explanation… sometimes they write a lot but their explanation must have words like… "electricity can flow through in the close circuit". This pair word must come together. Or.. electricity cannot flow through in an open circuit. So I explain to them you all must write, you can express your own way." (Tim)

Although Tim attempted to promote student discourse in KB, his facilitation made limited reference to KB principles. He only encouraged students to be more open to ideas (*Idea Diversity*) and to improve on their clarity of ideas (*Improvable Ideas*). As such, Tim's DoL reflected a "knowledge-transmittor" role to guide student learning through content knowledge. Furthermore, he tended to chart the learning process for the students by regularly assessing their ideas based on content knowledge. Thus, the teacher has a tendency to control the learning to emphasise "what is tested" or assessment procedures instead of letting students pursue promising ideas and expand their learning.

However, Alex's use of KF and LA focused more to improve student idea and to challenge students to improve thinking. For example, he meant KF as a tool for students to select promising ideas to enable deeper thinking about ideas. He also used LA such as scaffold analytics to let students visualise improvement in thinking. Such an emphasis on thinking was also evident in the way he facilitated collective reasoning and reflection. Mainly, Alex's facilitation of instruction explicit referenced KB principles. He was able to integrate various KB principles to support the idea improvement process in KB. The quotes below illustrate two examples of his principle-based facilitation:

> "In the Qin lesson example, I showed the Word Cloud to students and facilitated a discussion for them to develop rise-above questions from that stimuli. One example is that from the most-used words of 'bad' and 'people', students asked if Emperor Qin was bad to everyone and subsequently if his agenda, not deeds, were good or bad. Another example is that from a less-used word of 'perspective', a question was asked as to whether perspectives on Emperor Qin as a good or bad ruler changed over time. These were questions which show students were going beyond the dichotomous 'good' or 'bad' but digging deeper into the way we evaluate historical figures."[*Rise above*] (Alex)

> "One strategy I adopt is to show students the data (Scaffold Tracker bar graph) and allowing them to come to their own conclusion about their learning progress as a class." [*Community knowledge, collective responsibility*]

> "In the Qin lesson example, after allowing students some time in the idea improvement phase, I showed a snapshot of the data which showed that they were still generating raw ideas, i.e. using "My theory", instead of improving ideas, i.e. using the rest of the sentence starters to build on to their peers' ideas. After seeing the data for themselves, students made adjustments to their thinking by using more idea improvement scaffolds, as evidenced from a snapshot 23 minutes later which saw the synthesis scaffold, "Putting our knowledge together" increasing from the least used scaffold to the most used after "My theory", and the increase in other idea improvement scaffolds. (Alex)

Other principles evident from his instructional facilitation also include *Idea improvement*, *Idea diversity*, *Democratizing knowledge* and *Epistemic agency* (See Table 2 for details). The DoL

in Alex's activity system clearly reflected students charting their own inquiry as a class. For example, Alex highlighted how he let students "come to their own conclusion about their learning progress as a class" and "chart their own path of thinking if data is available to them". The teacher also explicitly mentioned that: "I was able to transfer more of the autonomy of learning to students as they used the visualised data to guide their individual and collective learning." He see himself as "a composer designing the ebbs and flows of knowledge building, but ultimately the ones bringing learning to life are students". Notably, differences in principle-based practice was also evident in the way the teachers perceived the student community. While Tim highlighted that he hoped for more students to read KF posts and to learn beyond the syllabus content learning whereas Alex wanted students to improve on discourse based on KB principle of "Constructive uses of authoritative sources.

Discussion

Our findings suggest some important "shift in practice" for teachers in principle-based innovation. As seen in the case of the two teachers' practice, it is important to align intentions with KB principles to support student learning beyond knowledge participation. As shown in Alex's practice, teachers should set goals beyond individual student conceptual learning or idea sharing and aim for a learning process of collective idea improvement supported by KB principles. In doing so, teachers' facilitation of KF and LA tools can focus on guiding students to reflect on their idea progression and moving forward in inquiry as a class rather than instructing students towards assessment procedures. It means that teachers need to move away from a procedure-based approach to learning and to emphasize less on reinforcing factual understanding. More essentially, teachers need to shift from a teacher-directed practice to a student-centred practice where students are given the autonomy to collectively chart their learning. To support teachers in enhancing their practice, one way is to connect teachers through KB community (KBC) so that they can grow in knowledge advancement of principle-based practice (Laferrière, Lamon & Chan, 2006). Further research can expand the use of activity theory to study teachers' interactions in KBC.

Conclusion

KB requires teachers to adopt a principle-based approach to support student learning. However, without close alignment of KB principles to support learning intentions, tool use and teacher facilitation, teachers may continue to adopt a teacher-directed learning and transmissive approaches to guide learning. Support for teachers require professional sharing in KB communities to enhance their understanding of principle-based practice.

References

Engeström, Y. (2001). Expansive Learning at Work: toward an activity theoretical reconceptualization. *Journal of education and work, 14*(1), 133-156.

Hong, H. Y., & Sullivan, F. R. (2009). Towards an idea-centered, principle-based design approach to support learning as knowledge creation. *Educational Technology Research and Development, 57*(5), 613.

Laferrière, T., Lamon, M., & Chan, C. K. (2006). Emerging e-trends and models in teacher education and professional development. *Teaching education, 17*(1), 75-90.

Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Eds.), Liberal education in a knowledge society (pp. 76-98). Chicago: Open Court

Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In K. Sawyer (Ed.), *Cambridge Handbook of the Learning Sciences* (pp. 97-118). New York: Cambridge University Press.

Yin, R. K. (2011). *Applications of case study research*. Sage.

Zhang, J., & Scardamalia, M. (2007). Sustaining principle-based knowledge building innovation at an elementary school. In *Annual Meeting of American Educational Research Association, Chicago, IL*.

Table 1: 12 principles for KB (Scardamalia, 2002)

KB principle	Socio-cognitive dynamics
Real ideas and authentic problems.	Knowledge problems arise from efforts to understand the world. Ideas produced or appropriated are as real as things touched and felt. Problems are ones that learners really care about—usually very different from textbook problems and puzzles.
Improvable ideas.	All ideas are treated as improvable. Participants work continuously to improve the quality, coherence, and utility of ideas. For such work to prosper, the culture must be one of psychological safety, so that people feel safe in taking risks—revealing ignorance, voicing half-baked notions, giving and receiving criticism.
Idea diversity.	Idea diversity is essential to the development of knowledge advancement, just as biodiversity is essential to the success of an ecosystem. To understand an idea is to understand the ideas that surround it, including those that stand in contrast to it. Idea diversity creates a rich environment for ideas to evolve into new and more refined forms.
Rise above.	Creative knowledge building entails working toward more inclusive principles and higher-level formulations of problems. It means learning to work with diversity, complexity and messiness, and out of that achieve new syntheses. By moving to higher planes of understanding knowledge builders transcend trivialities and oversimplifications and move beyond current best practices.
Epistemic agency.	Participants set forth their ideas and negotiate a fit between personal ideas and ideas of others, using contrasts to spark and sustain knowledge advancement rather than depending on others to chart that course for them. They deal with problems of goals, motivation, evaluation, and long-range planning that are normally left to teachers or managers.
Community knowledge, collective responsibility.	Contributions to shared, top-level goals of the organization are prized and rewarded as much as individual achievements. Team members produce ideas of value to others and share responsibility for the overall advancement of knowledge in the community.

Democratizing knowledge.	All participants are legitimate contributors to the shared goals of the community; all take pride in knowledge advances achieved by the group. The diversity and divisional differences represented in any organization do not lead to separations along knowledge have/have-not or innovator/non-innovator lines. All are empowered to engage in knowledge innovation.
Symmetric knowledge advancement.	Expertise is distributed within and between communities. Symmetry in knowledge advancement results from knowledge exchange and from the fact that to give knowledge is to get knowledge.
Pervasive Knowledge building.	Knowledge building is not confined to particular occasions or subjects but pervades mental life—in and out of school.
Constructive uses of authoritative sources.	To know a discipline is to be in touch with the present state and growing edge of knowledge in the field. This requires respect and understanding of authoritative sources, combined with a critical stance toward them.
Knowledge building discourse.	The discourse of knowledge building communities results in more than the sharing of knowledge; the knowledge itself is refined and transformed through the discursive practices of the community—practices that have the advancement of knowledge as their explicit goal.
Concurrent, embedded, and transformative assessment.	Assessment is part of the effort to advance knowledge—it is used to identify problems as the work proceeds and is embedded in the day-to-day workings of the organization. The community engages in its own internal assessment, which is both more fine-tuned and rigorous than external assessment, and serves to ensure that the community's work will exceed the expectations of external assessors

Table 2: Activity systems of the two teachers in KB practice

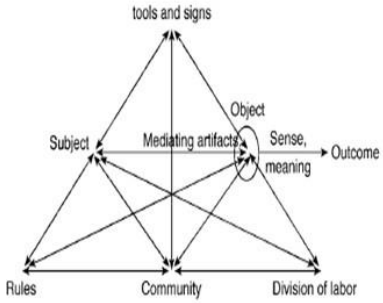
	Science		**Social studies**	
Subject	**Tim**	Supporting quotes	**Alex**	Supporting quotes
Outcome	• **Idea sharing from KB to promote communication skills and factual learning.**	• "… I think KB allows them to develop the 21st century competencies…" • "Collaboration, team work. Presentation skills…" • "… I say maybe you can, based on the possible causes, what are the possible solutions… because to propose solution you need to have the knowledge of the causes… then from there, you can see some of the negative… result of man's impact…"	• **Idea improvement and community knowledge advancement from KB to promote thinking and reasoning.**	• "… expose students to a microcosm of the hyperconnected, idea-centric society they will inherit, and hopefully have the skills and values to thrive in" • "…consider the ideas of their peers in a collective pursuit for knowledge" • "I look out for whether students are engaging with their peers' ideas in terms of either critiquing, supporting or synthesizing them to form new ideas."
Object	• **Students learn key curriculum words and explanations.** • **Students learn to share different ideas.**	• "Explanation with principle… that means there's science concept. Besides evidence, there's concept behind it. Key words, conductor. Must incorporate keywords." • "…in the future, the problem you [have] don't come from one discipline. It's likely to be a few disciplines. So… now, at their level maybe different ideas so you can embrace different ideas."	• **Students acquire deeper understanding of issue through idea improvement.** • **Student improve thinking through reasoning and promising ideas.**	• "In the idea assessment phase, I look out for the ideas students pick as promising in order to know if students have reached a fuller understanding of the issue." • "Another aspect I look out for in the idea improvement phase is the rising-above from the basic discussion to develop conceptual and overarching questions that unlock a deeper understanding of the issue."
Tools (Mediating artefacts)	• **KF to promote idea sharing.** • **LA to build correct science explanations.**	• "…like what i say, give them a problem, anchor question, they can go and discuss. It could be a problem then through discussion they find solution…" • "So this KB you could be: so let's say one person have a certain idea, another student B… so the sum is greater than its parts, some of them very powerful, link them together. Each one contributes." • "Through discussion discourse, you can build on one another's ideas or you discuss and talk about misconceptions all these and learn. Besides learning you can, who knows, you can from all the conclusions you can come up	• **KF to promote idea improvement.** • **LA to challenge students to improve thinking.**	• "Here the KF tool, "Promising Ideas" is useful as students select the ideas which bring them closer to answering the question at hand. [DoL – students select ideas] • "Scaffold Tracker" is useful because from the data I can tell whether students are using sentence starters aligned to thinking moves they should be using in this idea improvement phase, i.e. "This theory cannot explain"; "I can add on to this point"; "Putting our knowledge together"; "A better theory is"." • "In the Qin lesson example, after allowing students some time in the idea improvement phase, I showed a snapshot of the data which showed that they were still generating raw ideas, i.e. using "My theory", instead of improving ideas, i.e. using the rest of the sentence

		with a solution to the problem. Because one person might not have all the answers." • "… I also told them that a lot of them used my theory… I want them to discuss about the possible theory. I want them to use the putting of knowledge together, not just my theory. • "… "I can add on this point". They should use that scaffold. So for example why they choose the parallel circuit, some will say that it's brighter but there are more reasons than this. So they can use "I can add on this point" then they can think of other reasons: I can control the bulb independently, if one bulb fuse, the other bulb still can light up. So the scaffold I thought it's important. And sometimes I will tell them explicitly."		starters to build on to their peers' ideas. After seeing the data for themselves, students made adjustments to their thinking by using more idea improvement scaffolds, as evidenced from a snapshot 23 minutes later which saw the synthesis scaffold, "Putting our knowledge together" increasing from the least used scaffold to the most used after "My theory", and the increase in other idea improvement scaffolds."
Rule	• **Facilitation to assess/evaluate ideas.** • **Facilitation with limited reference to KB principles (only *Idea Diversity* and *Improvable Ideas*).**	• "I told them primary school the explanation… sometimes they write a lot but their explanation must have words like… "electricity can flow through in the close circuit". This pair word must come together. Or.. electricity cannot flow through in an open circuit. So I explain to them you all must write, you can express your own way." • "I think… it could be that when the current is too high, the wire melt right? So it's an open circuit. I think that's my understanding, I don't know whether it's true or not. Anyway the correct word that PSLE accepts is "fuse" or "blow". For battery, it will be "drained" or "flat". So all these are the key words. Because I'm not sure if they accept "dead" battery; dead is more layman. A lot of them like to use the word "power"; actually power we avoid using this word." • "…[StudentT] asked enemies are attacking because it's not very clear. What does he mean	• **Facilitation to support collective reasoning and reflection.** • **Facilitation with explicit reference to KB principles including *Idea improvement, Idea diversity, Democratizing knowledge, Epistemic agency, Rise above, Community knowledge, collective responsibility*.**	• "I look out for a diversity of ideas: whether students are providing a variety of ideas and not limiting themselves to a single perspective." [*Idea diversity*] • "In the Qin lesson example, I look out if there are many students swaying to the perspective that Emperor Qin was a bad ruler because he killed many people who challenged him – a view people often jump to. If that were to happen, one strategy I usually adopt is to be the devil's advocate, or get someone to be one. I do this by highlighting to the class or group "what others might say", e.g. Emperor Qin unified a common language and currency and thus actually benefitting many more lives of commoners. This brings light to factors that students might not have considered or placed importance on. Once I have 'instigated' some cognitive dissonance and made some students go, "Hmmm…", usually the class begins to open their thinking to explore these perspectives at the fringe of the dominant train of thought." [*Idea improvement*] • "In the Qin lesson example, I showed the Word Cloud to students and facilitated a discussion for them to develop

		by enemy? So I asked them to be more specific. Then [StudentZY] responded by saying what do you mean by enemy? With this enemy thing, you cannot explain the carcass if they're eaten. SO I picked a few to discuss." [*Improvable Ideas*] • "… I want to point out 2 things I want to develop further. One is… [StudentOH] said that it cannot be one reason, there are a few possible reasons. So I thought that was a very good point… There are new developments all the time. So you have to be open-minded. Especially this one: even the scientists not very sure what's the cause… we cannot be 100% sure; these are possible theory that's all." [*Idea Diversity*]		rise-above questions from that stimuli. One example is that from the most-used words of 'bad' and 'people', students asked if Emperor Qin was bad to everyone and subsequently if his agenda, not deeds, were good or bad. Another example is that from a less-used word of 'perspective', a question was asked as to whether perspectives on Emperor Qin as a good or bad ruler changed over time. These were questions which show students were going beyond the dichotomous 'good' or 'bad' but digging deeper into the way we evaluate historical figures."[*Rise above*] • "Usually this epistemic reflection is done as a class to 'close' to the lesson, e.g. "…and so what have we learnt about history?" This time I was interested what individual students thought." [*Epistemic agency*] • "One strategy I adopt is to show students the data (Scaffold Tracker bar graph) and allowing them to come to their own conclusion about their learning progress as a class." [*Community knowledge, collective responsibility*] • "providing an example of asking a rise-above question from a particular word in the Word Cloud, and to sustain it by fostering an affirming mood that encourages and positively reinforces exploratory questions and creative ideas." [*Democratizing knowledge*]
DoL	• **Teacher take on role of "knowledge transmitter" to guide student learning based on content knowledge.**	• "I told them primary school the explanation… sometimes they write a lot but their explanation must have words like… "electricity can flow through in the close circuit". This pair word must come together. Or.. electricity cannot flow through in an open circuit. So i explain to them you all must write, you can express your own way." • "Showed them a video. But that video I only showed half because I don't want to give away all the answer so I stopped at certain junctures of the video…"	• **Students chart own learning** • **Teacher take on role of "facilitator" to guide student learning using KB principles.**	• "This demonstrates to me and more importantly to the students that they can chart their own path of thinking if data is available to them." • "KB was able to allow a deeper exploration of the finer aspects of the question of evaluating historical characters and events, instead of skimming the surface. It also allowed for students to arrive at the answers to those questions themselves, which definitely helps in the retention of those ideas." • "I was able to transfer more of the autonomy of learning to students as they used the visualised data to guide their individual and collective learning."

		• "…. this notes here they mean, environment here they mean global warming. But can also mean, if you learn environment, it includes living and non-living factors. So there are predator and prey. So [StudentZY]'s understanding is more of this predator and prey thing. So I say both are correct."		• "In conclusion, ideally I would liken my role to a composer designing the ebbs and flows of knowledge building, but ultimately the ones bringing learning to life are students just like how musicians personalize a piece of composed music with their own character and style. Of course, sometimes an educator will have to step in as a conductor and provide direction and stability in the KB process, but once students get back on track, I usually am able to take a back seat and empowers students to steer their learning." [*Pervasive knowledge building*]
Community	• **Students to read KF posts for beyond content learning.** • **Students to improve on scaffold use.**	• "I think some of them have this passion. I might not see from all, but some of them have this passion, like they read beyond." • "Precisely. There are some who did. Actually when you propose solutions you want to use my knowledge. Maybe they don't understand… they still insist on using my theory."	• **Students to improve discourse on based on KB principles.** • **Students can progressively develop "growth mindset" and "divergent thinking"**	• "I would like my students to synthesize expert opinions with their own. For most of my classes thus far, I have seen little evidence that students engage in "constructive use of authoritative sources" in their discourse." [*Constructive use of authoritative sources*] • "it takes a while for students to get going. In my view, this is because it demands students to transit from a convergent thinking mode when they are critiquing and improving their peers' ideas to a divergent thinking mode where they are wondering about questions from stimuli, i.e. words from Word Cloud. This is compounded by the fact that in our education system, students are usually asked to provide answers instead of asking questions. • "From there a growth mindset toward learning can be forged… mindset where there is always something else to learn, something else to master, something else to struggle with. This is especially important for this profile of learners who sometimes think they already know everything there is to know."

Figure 1. Illustration of an activity system and definition of activity components (Engestrom, 2001)



Component	Definition
Subject	Human actors (Individual or group)
Objects	Objective or goal of activity
Tools	Physical tools and mental concepts (e.g. signs, language, computers, machines)
Rules	Formal or informal regulations that can, in varying degrees, constrain or liberate the activity and provide to the subject guidance on correct procedures and acceptable interactions to take with other community members
Community	Social group with which the subject identifies while participating in the activity
Division of Labour	How tasks are shared among the community