

# **A Principle-Based Approach to Engaging and Sustaining Teacher and Student Growth in Knowledge Building**

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## **Abstract**

In response to a major challenge for inquiry-based model and classroom innovation concerned with the constraints of task- and activity-based approaches, this paper outlines a design-based research for innovation to engage and sustain student and teacher learning and thus growth through a principle-based approach to deep understanding, and creative creation of new and diverse knowledge and solutions in knowledge building. Through a Knowledge Building Teacher Network in Hong Kong, mixed-methods, longitudinal data were collected from focused analyses of eight teachers in the network. Quantitative analyses reported changing patterns of student engagement on Knowledge Forum; and qualitative analyses reflected teachers' changing understanding and practice of knowledge building inquiry and pedagogy through the principle-based approach, involving principle-activity synergy and dialectics – principles may be scaffolds and indicators for realizing the core ideas of the model while activities and norms help clarify the principles as they are appropriated with varying contexts. Implications of how a principle-based approach may enhance socio-cultural capacity for teacher innovation are considered in an Asian context.

## Introduction

There is now widespread interest in developing inquiry-based and knowledge-building models in classrooms (Hmelo-Silver, Duncan & Chinn, 2007; Lin, Schwartz, & Hatano, 2005; Scardamalia & Bereiter, 2006). One challenge for teacher working on inquiry models is to shift from tasks and activities to principle-based understanding for deep changes in classroom innovation. Scardamalia and Bereiter (2008) contrasted a procedural -based with a principle-based approach – At classroom levels, reform-based approaches often degenerate into project activities and shallow constructivism when students are “researching on” or “collecting” materials for completing project tasks and activities. Such phenomena are labeled as “lethal mutations” by Brown and Campione (1996, p. 292) to describe the problem when teachers merely focus on surface features without understanding the key principles. For example, classroom implementations of reciprocal teaching often reduced it to its routines; scientific inquiry focused on skills rather than authentic scientific practice (Chinn & Malhotra, 2002), and knowledge building often involves students sharing opinion on Knowledge Forum rather than engaging in transformative discourse (van Aalst, 2009). A principle-based approach would be important for generative teacher growth needed for complex learning and adaptive metacognition (Lin et al., 2005).

This study is conducted in the context of teachers working on a knowledge-building educational model that emphasize students advancing community knowledge supported by Knowledge Forum, a computer-supported collaborative learning environment (Scardamalia & Bereiter, 2006). Many inquiry-based learning models (e.g., WISE) also place emphasis on design principles not merely activities. A principle-based approach takes this further – rather than focusing on tasks and sequenced activities, core principles of knowledge building are objects of inquiry – curriculum designs and classroom practice are examined through lens of principles; teachers inquire into and reflect upon these principles supported with classroom examples for improvable ideas and practice; (Scardamalia & Bereiter, 2006). With emphasis on student epistemic agency rather than learning of subject matter or skills, there are also needs for emergent and principle-based approaches to teacher learning. As teachers grapple with core ideas, they are more likely to experience epistemological changes with ownership.

Scardamalia (2002) has developed a set of principles for examining and designing knowledge-building inquiry and practice. A principle-based approach helps to characterize knowledge building (Zhang, Scardamalia, Lamon, Messina, & Reeve, 2007) and sustains teacher growth over years at a school level (Zhang, Hong, Scardamalia, Messina, Chew & Morley, 2011). Current studies are based on the work of highly experienced knowledge-building teachers. It is not so clear as to how this approach may work with less experienced knowledge-building teachers from different socio-cultural contexts. Whereas a principle-based approach de-emphasize routines and

activities, apparently, activities are needed in classroom. How this principle-based approach can be better articulated and how it works requires investigation. In Hong Kong, there is prior research on using knowledge-building principles to scaffold students' knowledge-building progressive inquiry (van Aalst & Chan, 2007). As well, our previous work has analyzed the growth of the Knowledge-Building Teacher Network (Chan, 2011); we have shown network teachers varying from focusing on techniques/strategies versus epistemologies in knowledge building classroom (Chan, Law & van Aalst, 2008) and reported on preliminary results of teachers engaging in a principle-based approach to innovation (Chan & Hui, 2012; Chan & Song, 2010; Chan, van Aalst, & Hui, 2011). This paper continues this line of inquiry with the following goals: (a) to investigate how to design and engage teachers in principle-based understanding in professional development; (b) to examine teacher changes through analyzing students' changing patterns of collaboration and discourse; and (c) to examine how teachers understand principle-activity dialectics in classroom innovation.

### **Designing a Principle-Based Approach for Teacher Change**

#### *Background and Research Context*

The Knowledge-Building Teacher Network (KBTN), consisting of around 50 teachers from different disciplines, began in Hong Kong in 2006 with a teacher “secondment” scheme funded by the Ministry of Education. In line with major educational reforms in Hong Kong, teachers were encouraged to engage in classroom innovation working with university mentors. While teachers took up major roles in the network, much attention was given to setting up infra-structures and tackling technology issues and classroom activities (2006-2008). In line with a design-based approach, the second phase of the project includes major design efforts shifting towards a principle-based design (2008-2010) (see also Chan, 2011).

Table 1  
*Towards a Principle-Based Approach in Designing for Teacher Knowledge Building*

Phase One (2006-2008)	Phase Two (2008-2010)
Infra-Structure and Teacher Activities	Towards a Principle-Based Approach
Teacher Professional Development Activities <ul style="list-style-type: none"> <li>• University researchers and teachers... Teachers helping teachers (seconded teachers) and sharing practice;</li> </ul>	Teacher Professional Development continued foreground principles <ol style="list-style-type: none"> <li>1) Knowledge Building Principles as Objects</li> </ol>

<p>peer mentoring</p> <ul style="list-style-type: none"> <li>• Diversified activities: (Design meetings of researchers with seconded teachers; Lesson co-planning and development of materials; School visits: Classroom observation &amp; practice; After-lesson debriefing; International Collaboration</li> <li>• Technology-supported inquiry- use of technology to support multiple schools and classrooms</li> </ul>	<p>of Collective Inquiry</p> <ul style="list-style-type: none"> <li>• classroom events and video as focus of inquiry from lens of principles; analyses of student writing on forum; teachers creating their collective understanding of knowledge building; problematizing and appropriating knowledge-building in light of socio-cultural constraints (e.g., exam)</li> </ul> <p>2) Principles developed through Community Dynamics – Collective Design, Reflection, Discourse to understand Principles; multiple zones of proximal development; teachers as peers and coaches; connection to international communities</p> <p>3) Principles enhanced through technology dynamics – teachers writing on Knowledge Forum to experience knowledge building; use of Applets and ATK for concurrent assessments for understanding principles; teacher-researcher-engineer work together discussing tool designs</p>
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1) *Principle as Objects of Inquiry and lens for classroom events (socio-cognitive and epistemological)*. This design emphasizes teacher inquiry into the knowledge-building principles to inform their design and practice. Typically, during the design meetings, one or two teachers would present an artifact from their teaching (e.g., a video clip, a selection of students' computer notes), which will be discoursed from the lens of principles. We also designed workshops that give explicit focus to principles supported with classroom examples at different levels of complexity drawn from various knowledge building databases and teacher practices. For classroom practice, teacher reflection was discussed with peer teachers from the perspectives of principles.

2) *Principles developed through community dynamics (social-cognitive and social)*. This theme emphasizes social dynamics needed for community building among teachers. Teachers facing reform challenges discussed constraints and tensions as they collectively grappled with

problems now enriched with a principle-based innovation *appropriating to socio-cultural context*. For example, Education Bureau (Ministry of Education in Hong Kong) begins to emphasize inquiry-based learning and network teachers discoursed changes in light of knowledge-building principles and community dynamics, moving beyond the usual ways of division of labor or student talk in groupwork in Hong Kong. There are *multiple zones of proximal development* with groups of experienced teachers, continuing teachers and beginning teachers scaffolding each other – the different levels of examples provided rich materials and contexts for examining principle-based design and practice. With a peer coaching approach, everyone is encouraged to contribute to advances in the community.

- 3) *Principles enhanced through technological dynamics (socio-cognitive and socio-technological)*. This design helps teachers to work on Knowledge Forum and employ assessment tools in ways that connect principles with classroom needs enhanced by technology. A core principle is community knowledge, and teachers use the tools for formative assessment to find out if students are developing community connectedness. The concurrent assessment supports sustained idea improvement as teachers and students assess their own progress; such feedback furthers redesigning and reinventing their classroom practice. Figure xx include some screenshots to show the principle-based approach to teacher development.

## **Analyses and Results**

### *Changes in Student Contribution and Discourse*

We first provided quantitative findings to illustrate changes among these teachers reflected in their student work followed with qualitative analyses of teachers' principle-based practice and understanding. Main analyses were based on data sources drawn from 8 key teachers, who work closely with researchers on knowledge-building in their classroom and serve as peer teachers. Data include semi-structured interviews, teachers' reflective diaries and writing on Knowledge Forum, teaching artefacts, and video clips of classroom episodes. We also included their students' writings and discourse on knowledge forum to analyze their participation patterns.

#### *Changes in quality of student discourse patterns.*

We investigated the quality of student discourse on Knowledge Forum (KF) for network teachers for overall network growth (2006-2010) with this principle-based design. KF databases typically consisted of several discussion views; the best one was rated using a 4-point scheme adapted from types of discourse (Chan & Fu, 2011; van Aalst, 2009). Results show a small but general increase from fragmented to knowledge construction-creation discourse over years.

Table 2

*Changes of the Quality of Student Discourse on Knowledge for KBTN, 2006-2010*

Year	Quality rating of student discourse				Number of Classes
	Fragmented	Knowledge sharing	Knowledge construction	Emerging knowledge creation	
2006-2007	12 (30%)	18 (45%)	7 (17.5%)	3 (7.5%)	40
2007-2008	28 (41.0%)	23 (33.7%)	7 (10.8%)	10 (14.4%)	68
2008-2009	8 (12.7%)	37 (58.7%)	12 (19.1%)	6 (9.5%)	63
2009-2010	10 (18.9%)	20 (37.7%)	15 (28.3%)	8 (15.1%)	53

*Note.* Extracted from Chan (2011, p. 167).

*Changes in student contribution and connectedness.*

Quantitative analyses were conducted to examine changes of student participation of the key teachers. A core principle is *community knowledge* that can be reflected in *contribution and connectedness*. Three indices from the assessment tools, adapted from Zhang et al.'s study (2011), include: (a) students' contribution to the community, based on the number of notes *written*; (b) their awareness of the contribution of others, based on the density of note-reading; and (c) their connectedness with others' ideas, based on density of *linked* and *build-on* notes. These indices show increased contribution and connectedness, and preliminary statistical analyses indicate that there were significant differences on these indices across years for most of the teachers. While these teachers vary as they appropriate knowledge building to their context, these indices seem comparable to those of experienced knowledge-building teachers in Canada (Zhang et al., 2011).

Table 3

*Changes of Student Contribution Towards More Connectedness Based on the Knowledge Forum Applet Indices for Teachers*

Teacher	Number of notes written		Note-reading density		Build-on density	
	2008-2009	2009-2010	2008-2009	2009-2010	2008-2009	2009-2010
TWK	8.7	12.8	84.5	99.8	29.2	32.7
TYW	4.5	8.7	79.7	90.6	18.6	42.5
TBF	5.5	19.2	41.66	85.71	13.76	32.63
THT	19.9	25.2	94.2	95.4	27.36	33.23
TPY	12.2	12.5	95.15	100	33.28	37.98

TSW	10.1	4.2	82.07	97.89	17.63	26.84
TSY	6.7	17.7	66.31	90.64	16.29	31.41
TWS	5.0	14.8	80.55	88.06	19.66	43.37

Note. Modified from Chan (2011, p. 167).

Changing student patterns provide some support to teacher change using knowledge-building with a principle-based design. The following qualitative analyses seek to illuminate how these student changes towards more connected communities may be possible. As well the analyses highlight themes of principle-based design and teachers' principle-based understanding.

### Changes in Principle-Based Classroom Practice

In the early years, teachers tend to use fixed groups and student discourse is linear as student are merely writing to teacher question as though they are working on assignments (characteristic of Hong Kong classrooms). As teachers work collaboratively grappling with principles emphasizing community advances, there were changes towards more divergent patterns of discourse (Figure 1).

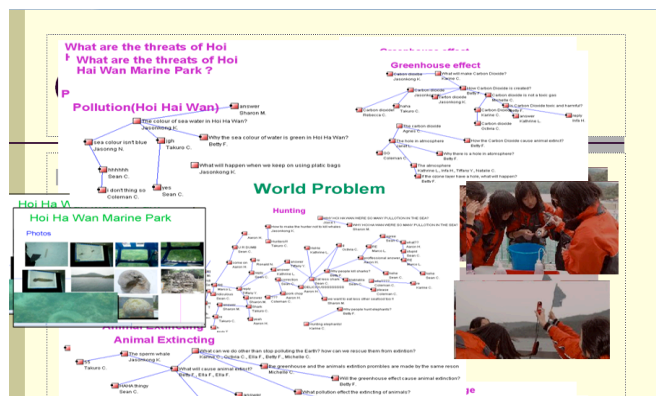
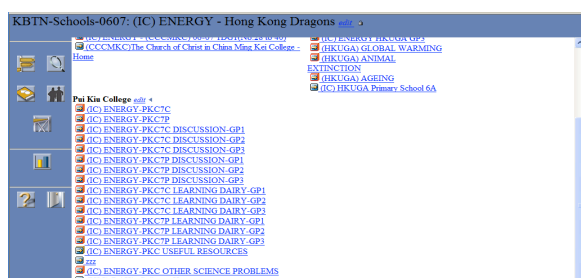


Figure 1. Changes from teacher-guided discussion to rise-above views designed by students

Interview data further suggest how a network teacher moved gradually from an emphasis on teacher-led classroom activities to more focus given to student roles and gradually shifting more

emphasis towards core notions of knowledge building grappling with the notion of improvable ideas. Below shows an example:

- “I rack my brain to think of activities for my students.” (2006-07)
- “For improving my practices on knowledge building, I would like to have better curriculum design, such as designing more experiments and letting students design and perform their own experiments.” (2007-2008)
- “The important thing is... from the beginning up to the end, we need to *emphasize to students* that we are working on ‘improvement’ ... and improvable idea is very important...it would give students opportunities to search for data and make use of ‘authoritative information’ to support their theories or to [formulate] solutions to their problem.” (2009-10).

#### *Teacher Epistemology: Teacher Understanding of Interwined Principles and Activities*

Teachers’ understanding of how principles may support their work can be examined in the following themes.

***Principles to explain and to provide meanings to activity structure.*** A first theme is that teachers articulate the importance of having principles to provide explanation of what they are doing.

“Something that is special ...is the emphasis on *principles and theories*. In other programs, we are taught to do different activities and use the tools so we can have better ways to teach our students... This one seems different because it has theories and principles to help us to think *why we are doing* and *what we are doing*” (Teacher F).

***Principles to transfer across context and to provide purposes/value.*** The second theme, illustrates further how principles works across context and provides purposes:

“I guess it is important to work with principles – They help me to understand why certain activities work in *some contexts and not others*. They also provide the *purposes* behind of what and why I am doing certain things. ...” (Teacher E)

***Principles as scaffolds; generative and going beyond.*** Another theme shows how principles can be scaffolds for reflection and generative growth.

“After observing teacher lessons or co-teaching...we need to debrief using these principles... or else new teachers do not know what is going on...in fact, it is the same for students...so I talk to students about principles but use simpler words.”



“What I wanted my mentor to do is ...to let me know the principles behind. I want my mentor to understand the knowledge building approach well and to be able to discuss with me why certain approaches may work or not.”

“If he told me the *procedures*, I can at most follow what he can do and sometime do a bit less. It is great that *my mentor shows me many examples* and ... explain the principles of the design and with that understanding *we can continue to construct something new.*”

***Principles as executive control to regulate different activities.*** This theme illustrates how principles can be used to select and regulate use of activities.

“I do have lesson plans when I teach but usually different things can happen in the knowledge-building classrooms...when things happen differently, I have to change and be flexible... so these principles ...almost help me to decide what is important...they also help me help me to capture the good things...I can see in my students...”

***Principles made explicit – activities as pointers to clarifying principles.*** Another theme shows how abstract principles are made explicit and how they work in classroom.

“I worked with my students on principles...and asked them to show examples...they discussed...whether they felt they had improved their ideas and whether they were working and advancing together... they were the one to show if they had improvement.”

“It does not matter how my students grouped or wrote their report...they key things is they need to contribute and advance together...um... I also find ways to do that... when I see that someone is contributing useful knowledge..., I will point that out to my students saying... ‘See! This is what I mean and how it works...’ I am actually working with my students; they produce the work (evidence) that helps me explain.”

As students demonstrate what they can do, the teacher used the instance to help the community recognize principles; teachers and students can be generating new knowledge and understanding collectively.

## **Discussion**

This study examined a principle-based approach to knowledge building in the context of teacher learning and teacher community in Hong Kong classrooms. There has been much progress in inquiry-based learning but how teacher learn about inquiry models such as knowledge building remains a challenge.

Such findings are in fact consistent with the literature on how experts focus on principles

whereas novices attend to surface features in conceptual learning (e.g., Chi et al., 1983). In this case, principles are examined in teacher learning, and the importance of principles is consistent with research on teachers' adaptive expertise (e.g., Lin et al., 2004). Although the teacher development literature focuses on teacher experience and reflection, this study proposes that teachers can also be presented with theories and principles as objects of inquiry.

While there are controversies between principle-based versus activity-based approach in classroom design, the differences and tensions need to be better articulated. Primarily, principles and activities are not exclusive or polarized but can be considered a continuum for understanding pedagogical approaches; principles and activities can also be synergistic. Design principles are commonly examined and developed in inquiry-based approaches; and on the other hand, a principle-based approach in knowledge building does not disregard classroom activities and participant structure (for example, see Caswell & Bielaczyc, 2001). Nevertheless, knowledge-building model does place principles to the fore-front more so than other approaches; and it can be considered the most emergent approaches amongst others. Knowledge building include participant structures such as knowledge-building talks or reciprocal teaching; they are not pre-arranged or sequenced but used when needs arise. Some conjectures can be made about such tensions relating to the notion of theory-pedagogy-technology coherence. Different theoretical models may have different goals and focus, for example, in various inquiry-based approaches (e.g., Learning by Design), there are important benefits for activity structures and routines and norms so students can develop expectations as they engage in iterative cycles and repeated practice revisiting and restructuring their models. When emphasis is placed on subject-matter learning, structured guidance and scripting may help with individual and group learning outcomes. On the other hand, knowledge-building model deemphasizes scripting, structure and routines to maximize agency, self-organization and complexity in emergent knowledge work.

Our results also suggest a major question is to examine more deeply the nature of a principle-based pedagogy in knowledge building. Data analyses suggest that principles are important but they are also intertwined with activities – teachers from Hong Kong noted that principles are needed to help to explain why certain activities; provide scaffolds for reflection; help generate new knowledge and practice; and monitor the use of activities. Principles need to be made explicit to help highlight the goals of the community; and activities can be pointers that may help clarify the abstract principles. A principle-based approach enriched with activities suggests that teachers and students need to attend to cognitive and epistemic goals with intentionality. Principles may be scaffolds, pointers, and indicators for realizing the core ideas of the model while activities, routines and norms may be appropriated with varying socio-cultural context.

As knowledge building is conducted in Asian classrooms, there are variation in activities and

practice, such as when Knowledge Forum is to be introduced and alignment with assessment in relation to examination. There is a delicate balance between lethal mutations of distorting the model to fit existing practice versus appropriating the model to the educational context – a principle-based approach may offer possibilities when examining such dilemmas. Continuing investigation into the controversy of structured versus emergent inquiry may help shed light on how teachers come to understand inquiry-based learning and knowledge building classroom innovation.

## Conclusions

This study examines a principle-based approach to knowledge building. Three design themes on principles as objects and lens of inquiry, principles appropriated with community practice and principles enriched with socio-technological dynamics aim to scaffold *epistemological, socio-cognitive and technological* dynamics of teacher communities. Longitudinal and multiple data suggest teachers' changes from activities towards principle-based designs and epistemic focus on principles-practice dialectics. Such teacher changes are also reflected through student changes in discourse and participation patterns.

In terms of our design efforts for teacher communities, it may be argued that most teacher development programs also consider the application of principles (e.g., WISE) but knowledge building put principles to the forefront (Scardamalia & Bereiter, 2006). In Hong Kong with much emphasis on strict curriculum, routine practice and examination pressure, initially teachers generally felt principles as very remote to their classroom practice. A design-based approach to teacher professional development included obstacles in early days with continual refinements; primarily we encouraged teachers to work collectively with principles as something *problematic* to understand, and they are to examine classroom events and student talk/discourse from the lens of principles. Community dynamics support teacher inquiry and technology helps them see how principles may work and how may be realized. In some ways, such an approach put teachers in the situation of knowledge building – they are not merely learning about how to enact knowledge building pedagogy in classroom, they are engaged in knowledge-building dynamics with possibilities for emergent knowledge creation.

Major controversies exist between structured guidance versus principle-based approach (Kolodner, 2006; Kirschner, Sweller, & Clark, 2006). A major question is to examine more deeply the nature of a principle-based pedagogy in knowledge building. Primarily, principles and activities are not exclusive or polarized but can be considered a continuum for understanding pedagogical approaches; principles and activities can also be synergistic. Knowledge building include participant structures such as knowledge-building talks or reciprocal teaching; they are not pre-arranged or sequenced but used when needs arise. Data analyses suggest that principles are important but they are also intertwined with activities – teachers noted that principles are needed to

help to explain why certain activities; provide scaffolds for reflection; help generate new knowledge and practice; and monitor the use of activities. Principles need to be made explicit to help highlight the goals of the community; and activities can be pointers that may help clarify the abstract principles. A principle-based approach embedding activities suggests that teachers and students need to attend to cognitive and epistemic goals with intentionality. Principles may be scaffolds, pointers, and indicators for realizing the core ideas of the model while activities, routines and norms may be appropriated with *varying socio-cultural context*.

While there are continuing challenges, a principle-based approach would be important for epistemological changes needed for generative teacher growth and reform efforts. As knowledge building is conducted in Asian classrooms, there are variation in activities and practice, such as when Knowledge Forum is to be introduced and alignment with assessment in relation to examination. There is a delicate balance between lethal mutations of distorting the model to fit existing practice versus appropriating the model to the educational context – a principle-based approach may offer possibilities when examining such dilemmas. A principle-based approach may help realize the notion of knowledge creation as teachers and students build new knowledge. Continuing investigation into the principle-based approach may help shed light on how teachers transform their practice for knowledge creation innovation in 21<sup>st</sup> century education.

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