Submitting to thread:

Design-Based Research Aimed at Increasingly Deep Levels of Knowledge Building
SUSTAINED WORK WITH IDEAS: Beyond inquiry methods that support question asking and idea generation to methods that support continual idea improvement leading to deeper understanding and competence

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Title: NATURE OF PROBLEM SPACES IN KNOWLEDGE BUILDING PRACTICE

Abstract

This paper builds on a variety of models of teacher thinking and development to propose a problem space model (Figure 1a, 1b and 1c) specifically geared to the development of Knowledge Building practices. This model aims to provide a theoretically- and empirically-based description of shifts teachers undergo as they gain skill in Knowledge Building pedagogy. This perspectival shift, from a centrist to relational, is examined in five problem spaces: Curriculum/Standards, Social Interaction, Student Capability, Classroom Structures and Constraints, and Technology. Underlying the centrist perspective is a belief in established procedures and goals typically understood to characterize effective teaching. Underlying the relational perspective is a belief in the capacity of students to develop and improve their own ideas, and a belief that in doing so students will not only mature as knowledge-builders, but will also excel in the achievement of traditional knowledge goals. The research uses teacher interviews to analyze the work of a group of 13 teachers over a full school year. Results show that Knowledge Building teachers construct and explore the same problem spaces as other teachers. What distinguishes them, and places them on a different trajectory, is the relational approach that brings ideas to the centre in each problem space. The work of teachers with different levels of experience is analyzed to characterize the centrist to relational shift, which corresponds to three embedded shifts (a) surface to deep interpretation of problem and processing of information, (b) routine to adaptive approach to classroom activities and student engagement, and (c) procedure-based to principle-based reflective action.

Introduction

This paper analyzed and explored teaching practice through an analytical, exploratory study, to uncover problem spaces generated and explored by a group of Knowledge Building teachers of different years of knowledge building experience.

Schon's concept of reflection-in-action, as contrasted with reflection-on-practice (1983) has been widely adopted in education, and represents an essential component of an idea-centred classroom. Common criticisms of reflection–in-action are that its conception does not consider the "hot and rapid" responses required of teachers in messy and chaotic situations (Eraut, 1995) and that the nature of the professions (i.e., architecture, design, music performance) described in Schon's work deviates from that of teachers' work in real classrooms. It is likely that without a set of principles to govern their teaching and learning, teachers would not be able to perform reflection-in-action on core pedagogical issues. This assumption sets the context for this study, as teaching and learning problems are complex and ill defined, and require fast-paced decision making. In Knowledge Building practice, teachers operate as designers, in the same reflective manner as in design professions requiring deliberative processes that emphasize intentions, plans, and mental effort in learning (Bereiter & Scardamalia, 1989). Knowledge Building

pedagogy requires principle-based, as opposed to procedure-based, action and Principle-based action requires adaptive expertise, a form of "expert knowledge that supports continual learning, improvisation, and expansion" (Bransford et al., 2006).

Applying the concept of problem space (Newell & Simon, 1972; 1980) in understanding such reflective practice, we see it as a representational concept used in this study to frame the way we understand teachers' thinking in generating and exploring problems in their daily work. A premise pursued in this paper is that the nature of teachers' work within these problem spaces enables or thwarts problem analysis, procedure-based action to principle-based reflection-in-action, and adaptive expertise. Within the problem space literature, the concept of a problem space is generally used to understand how problem solvers move towards their goals through a series of actions, broadly categorized along two dimensions: (i) generating the problem space, and (ii) exploration of the problem space. These problem-solving processes are distinctive for complex and ill-defined design problems, as contrasted with well-structured problems. Typically teachers oversimplify classroom situations to avoid complexity and address the problem in the time available. In most cases, the decision is quick and routinized, so there is no attempt to problematize the situation, let alone to consider new possibilities. Follow-up reflection is at best an exercise in rationalization rather than deliberate reflection-in-action. Understanding teachers' construction and exploration of problem spaces is essential if we are to encourage reflection-in-action and adaptive expertise in teaching.

The research question is: what kinds of problem spaces do Knowledge Building teachers construct and explore?
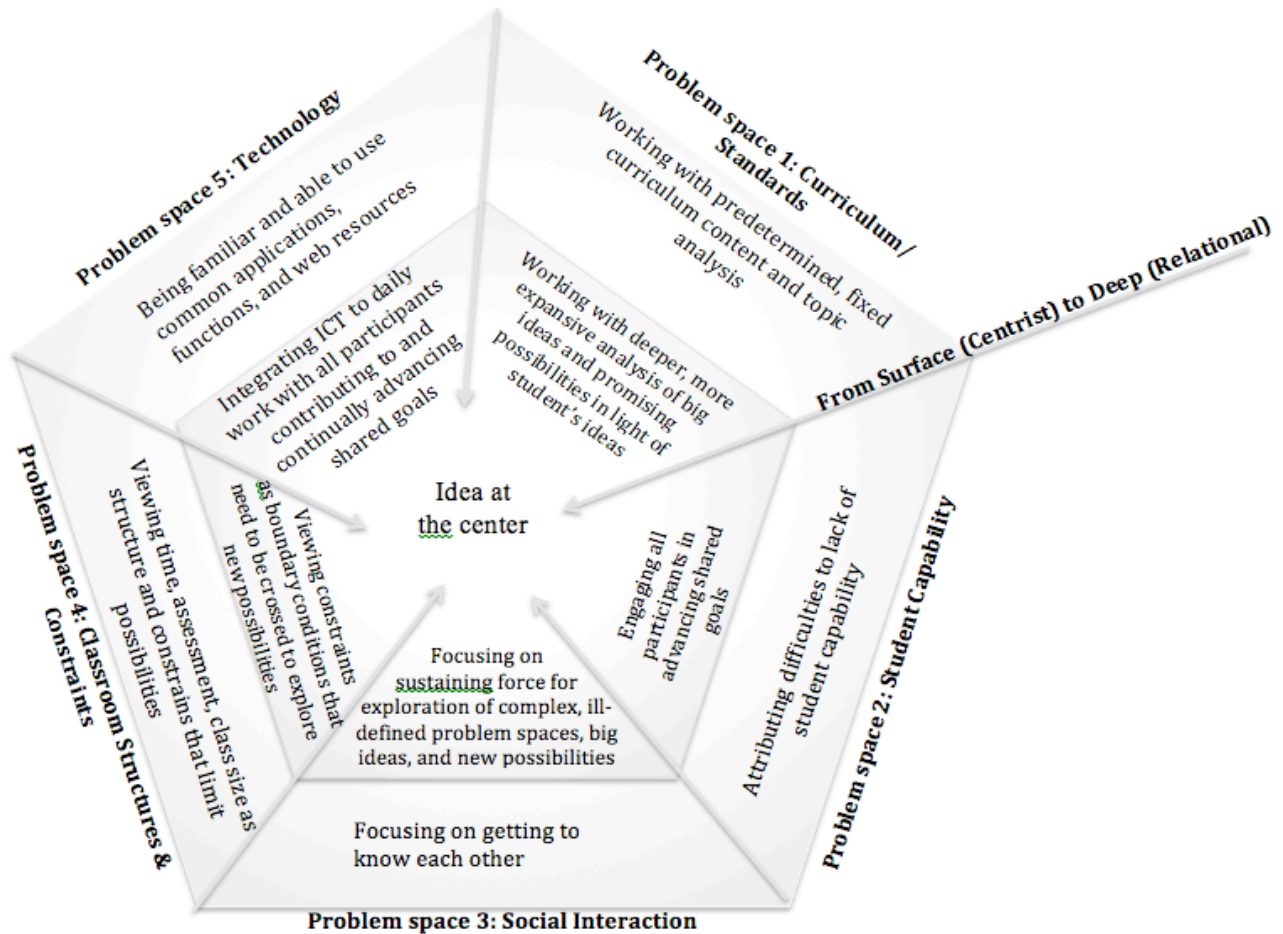
Figure 1a. Centrist to Relational Perspective Underlying Pedagogical Shift from Surface to Deep Features of Problems in Five Problem Spaces.
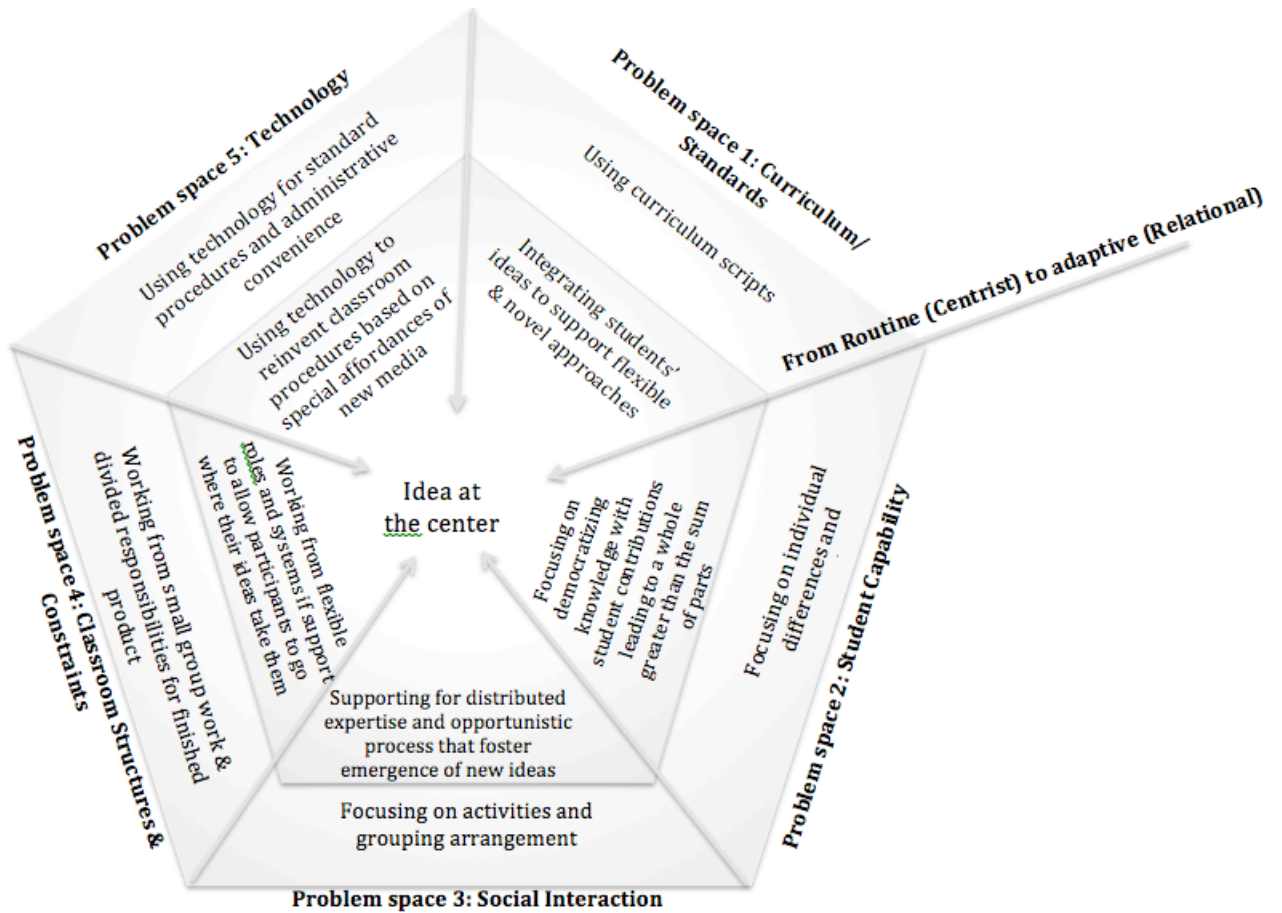
Figure 1b. Centrist to Relational Perspective Underlying Pedagogical Shift from Routine to Adaptive Approaches in Five Problem Spaces.
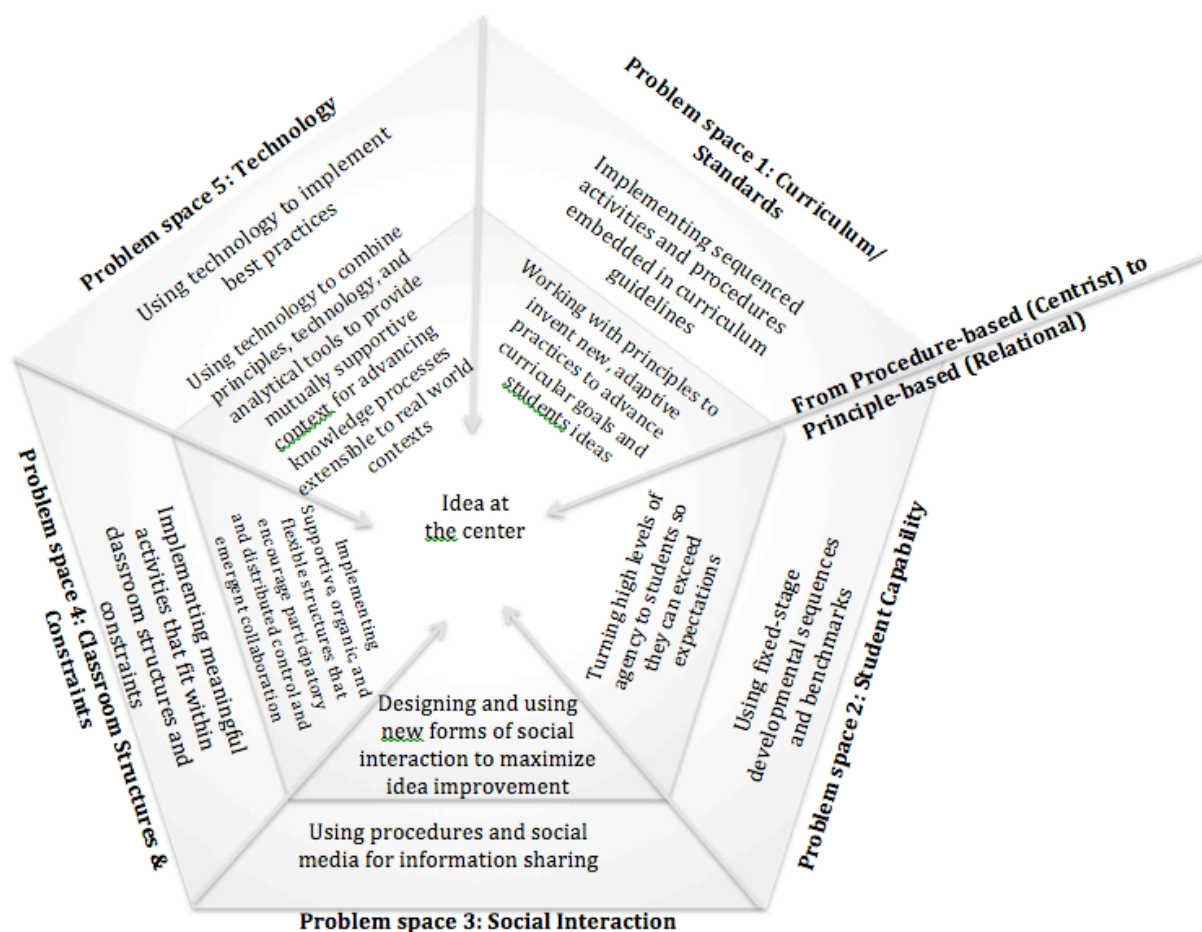
Figure 1c. Centrist to Relational Perspective Underlying Pedagogical Shift from Procedure-based to Principle-based Reflection in Five Problem Spaces.

Methods

Extensive data collection and analysis are used to understand teachers' perspectives regarding five problem spaces and how their roles in class affect their engagement in communal discourse, and the kind of knowledge they finally employ in their own practice.

The problem space model (Figure 1a, b, c) is used to guide the analysis and description of shifts teachers undergo as they gain skill in Knowledge Building pedagogy.   The model also serves to convey how Knowledge Building teachers differ from other skillful teachers, with the principal shift from a centrist to relational (or systemic) perspective. This perspectival shift is examined in five problem spaces: Curriculum/Standards, Social Interaction, Student Capability, Classroom Structures and Constraints, and Technology.

Data collection methods included semi-structured interviews, meeting discussions, and written journal entries.

Participants

As the purpose of the study was to examine an authentic and established Knowledge Building culture and differences among teachers with different years of experience, the choice of participants and school was obvious. Participants were 13 teachers of different years (< 2 years; 2-5 years; > 5 years) of Knowledge Building practice from the Dr. Eric Jackman Institute of Child Studies (Jackman ICS) Laboratory School, Ontario Institute for Studies in Education, a school affiliated with the University of Toronto. This school has successfully sustained Knowledge Building practice for over a decade (Scardamalia, 2002; Bielaczyc & Collins, 2006; Zhang et al., 2010). The years of experience is used to explore behavior along a continuum rather than using a strict novice-expert division.

Data Collection and Analysis

The 13 teachers at Jackman ICS were interviewed individually to understand how they approached and improved their teaching. They were asked broad-based questions to determine the extent to which they reflected on and analyzed their practice. For example, they were asked, "How do you see the role of yourself as a teacher relative to a researcher?" They were also asked more specific questions about teaching practice, such as "What are the three most important qualities you would like to develop in your students?" and "What are the most important efforts you make to enable your class to operate as a community?" and "What are the major challenging issues you encounter in your classroom?".

The video recordings of the individual interviews with teachers were transcribed. Text was segmented and coded. Each segment of the interview transcript was coded according to (i) the type of problems identified by teachers and (ii) the reflection and formulation of strategies by teachers in the five problem spaces identified from the literature, namely Curriculum/Standards; Social Interaction; Student Capability; Classroom Structures and Constraints, and Technology. Each problem space is further analyzed mainly for the shift between centrist and relational perspective.

Results: Problem Spaces Constructed and Explored by Teachers with Different Levels of Knowledge Building Experience.

The analysis that follows is a qualitative analysis of teachers' interview transcripts, to provide an introduction to the five types of problem space that these teachers constructed and worked in, with an indication of centrist or relational perspectives. Overall, teachers with more Knowledge Building experience elaborated work in more relational perspectives inherent in them. Excerpts from teacher interviews are used to provide an indication of centrist and relational perspectives for the five problem spaces *Curriculum/Standards*, *Student Capability*, *Social Interaction*, *Classroom Structures and Constraints*, and *Technology*.

Curriculum/standards

Katie, teacher with <2 years of Knowledge Building experience described possible classroom activities such as "small-group instruction, one-to-one time" in the following comments, suggesting a fairly centrist perspective on features and procedures:

> "I fixed conversation small-group instruction, one-on-one time, students can choose resources, e.g., book choice. We do a lot in Grade 4, through parent involvement and open dialogue and trying to provide authentic experiences for children concept-learning instead of just giving children an opportunity to play."

Another quotation from Nancy, a teacher with 2-5years of Knowledge Building experience also reflects a focus on procedures, more in line with a centrist perspective.

> "I take a little group out and do some research on water, and they talk about questions they have and [I] help them research them, so it always has to apply (to the topic), or otherwise I do a lesson on dictionary, and it is just a worksheet, but it doesn't make sense unless it (the lesson) applies (to the topic). It is the matter of finding those moments that the kids need that lesson, and pulling out the lesson and creating right away. So it is the right time and right subject, so it works. So that would be for the collecting or being able to research, and also critical thinking, because especially the beginning they just copy down what the book says, so I'll say, "is that helpful?", "Is that answering your question?" I'll close the book and ask them what did you read, and see what they can say."

In contrast to the two quotes above, we see a more relational approach from Chloe, a teacher with +5 years of Knowledge Building experience, reflecting deep analysis and adaptive flexibility:

> "I think a watershed moment for me, as a teacher, happened in my first year of senior kindergarten. It wasn't my first one but it was a very important. It was the very first day

of school, and I have told the story, unfortunately, before, but I thought it would be interesting to do a study on tree, and whenever I think about a broader topic that we might have been looking at, I think about how I can impact their interest in class, I try to think where they would go. Every year, they bring leaves to class, every year in the fall, they bring it in,; I figure they would be thinking of the leaves and the color and maybe get to the sap, I have not gone beyond that, I was going to wait for the kids. The very first day, the kids knew about trees and as they told me about trees, somebody said, branches, the root went in, twig went in, nest went in, and then a child said, lungs. And I just stopped and it was an important moment for me, because it makes it explicit that about trees have lungs. I don't think I would have said that. But in such a clear way, it puts me in an interesting position, so I said, where would I put the lungs, and she said I don't know, but they have to breathe, don't they, they are alive. So for the next month, we looked at how a tree breathes and that caught the interest of the class."

Student capability

Teachers with <2years of Knowledge Building experience, e.g. Bruce, tended to focus on obvious, evident, or surface problems when managing students' capability to participate in knowledge building:

> "I talk about my expectation a lot, nothing we do should be taken too seriously and people should not feel hurt and the other thing I try to do is emphasize why are we doing what we are doing, e.g., soccer, we are doing it to improve our skill, we are not doing it so we can see who is the better soccer player."

They also create general plans:

> " … through observation and engagement with the students, thinking, OK, have the students now mastered this, what can I do differently next time, tomorrow, immediately to improve their learning. So a teacher always has a question of themselves, how the students are moving forward, how they can change their style of teaching and how they can reach the students to change their misconception or classroom practice or whatever it may be that they identified." (In Dorothy's interview)

Teachers with 5+ years of Knowledge Building experience tend to provide a deeper analysis of students' capability to display ownership of learning. The following are two examples:

"[I]n the children in my class, I think the most important one is independence in their thinking, I want the children to make independent purposeful choices about how they spend their time in class, so when they are presented with the question, or a bunch of material, or an open time frame, that they can be thinking about in a very purposeful way about how they are going to pursue it, whether it is playing in the yard, or in a math class or thinking about big question, or the sound unit that we are doing, I want them to be knowing that they can act independently, they don't need a teacher to guide them a whole way and telling them what is right or wrong." (In Chloe's interview)

"[W]hen they come to school, they don't see the work of school as just being in school, they see it as important in their life, and the thing we are doing felt important to them and they think about it at night. [They] like the question, they ask their parents and search their internet, so school feels like an important thing in their life, not just something they do and leave. So that pervasiveness of Knowledge Building, I just like it to be part of their learning." (In Zahra's interview)

Social interaction

Premela, an experienced teacher but with less than a year of Knowledge Building experience described possible classroom activities to support students as a community, suggesting a fairly centrist perspective on features and procedures:

"I do exactly that when we do a class, but I also do a lot of talking about classroom as a community, us being a community, us being a team, we could help each other, e.g., in the yard, hang together and we build, we eat together a lot. When I [was] in my old classroom, we would have a supper day where we sit and eat with each other, we listen to each other. This happened in circle. We eat together, it happens that way."

Teachers with fewer years of Knowledge Building experience, i.e., <2 years, tend to adopt a centrist view when managing *Social Interaction problem* space; e.g., responding to the "right question." Such intuitive reactions might compromise the kind of idea-centred work for which a Knowledge Building community is known. Bruce, as a less experienced Knowledge Building teacher, shared how a more experienced teacher's can respond to students in a KB Talk showed the contrast between an experienced and a less experienced Knowledge Building teacher's (himself):

"There is one moment where I fell like I really got it; it was when Chloe [5+ years of Knowledge Building experience] was telling the story, reading a transcript of KB talk in her SK class. About astronomy, sun and the moon, she was describing the light bulb illustrating the sun, where day and night came from. She was reading through it, appropriate, myth, God etc.…then one child got up and was walking around the sun, and

rotating as she said it, she figured out where day and night come from at the age of 5, but when Chloe read it, she had the same response as to the other theories, she just said, oh, that is a great theory, would someone have another theory? I would have said, Yes, you got it! Let's everyone try to understand it.' Now, what I realized when Chloe read the story . . ."

In the following example, Chloe, with more than five years of Knowledge Building experience, talked about an overarching principle corresponding to Knowledge Building principles such as "listening to ideas in a very open way" to improve students' respect for each other.

> "[T]he second one, for me, [was] really understanding how important respect is in a classroom, that every voice deserved to be heard, their own voice deserved to be heard, that it is not what is about the teacher said, about what they want; we need to hear what everybody said, if you can really build the foundation of respect. It means if you are sitting on a carpet with 5-year-olds or 12-year-olds, it means you can have a real conversation, you don't always have the same voices in charge, and it means you are listening to ideas in a very open way, so people are more likely to share their ideas with you."

More expert teachers, e.g. Nancy with 3 years of Knowledge Building experience, also tended to break down surface problems and identify deep features of problems: "I am trying to find out a lot about the children..."

> I think first I asked questions, I ask a lot of questions; that is, I am trying to find out a lot about the children, about their feelings, their conflict, their family [so] I know better how to support them. For the community is my own knowledge about them. Both by modeling and finding out about each other, also when I know the children well, it helps me to support them as individuals; I expect them to work and to listen to each other. We put quite a lot of thought on how we group the children in different ways. We think about if it is more helpful for them to work on their own or as a group. Many things we feel we have to talk as a community, as a whole class, because of that sense of community without anyone not being involved."

Chloe also try to create community dynamics to support knowledge advancement

> "And then again, just respecting their interest makes them feel so much a part of what they are. I also try to make it clear to the children, you don't have to be friends with everybody, it is important to say not everybody here is your friend.They are not going to believe you if you force something to them, you lost their trust. But I said everybody here is a member of the community, so you don't have to love them, but you do have to treat them with respect and with kindness, that means you have to

> treat them with respect and kindness, you have to treat their ideas with respect and kindness, their work with respect and kindness, we do talk about it a lot…"

Classroom structures and constraints .

Most teachers were aware of the need to design and influence either the curriculum or the classroom structure to facilitate knowledge building; however, the teachers newer to Knowledge Building tended to focus on surface issues of classroom structures and activities. Here are two such examples:

> "One of the main aspects is physical, the couch. When they first come, they all fit onto the couch; gradually we add chairs when they get bigger. When they are here, they see each other and they can relate with each other. I sit with them to build community, then sometimes it is all of them against me…That works well. Sometime I build a pattern in the seating so not all boys sit together. We mix and match, this way there is more sense that everybody is equal. And we have to work in smaller teams, and we change the teams all the time and not just one group that help each other. That is the best way." (In Bruce's interview).

> "The other one is time. Consider the community, the rich curriculum, arts, languages, and physical experience. In Grade 4 schedules, the day is broken into half hour time slots with transitions to other things. Very difficult for them to feel invested and move on. Our days felt like 30-minute time slots. When now, they want to ask a question and for me [we can't]. That is the biggest frustration." (In Katie's interview)

Teachers with 5+ years Knowledge Building experience (in Chloe's example), show adaptive flexibility--innovation along with concern for efficiency—as well as commitment to move towards big ideas and principle-based use of time and discourse:

> "I think that it is one thing that as school and teacher, we don't do enough of: we don't give children enough time to follow through with what they are doing, so I try to give them time in a day and I try to give them time across a unit, so we don't spend two weeks on something, so we let it go as long as it makes sense, which may be you never know. I didn't use to do that when I [was] a early year teacher, but now I am much more comfortable just letting them run along as long as they think it is valuable."

> "I am careful about what the 'big question' might be for KB Talk so that there will be ample opportunity for a variety of ideas. I also try to plan for ways to draw the conversation away from absolutes and towards more hypothetical or theoretical discourse."

Also, this teacher with mid-level Knowledge Building experience (Nancy, 2-5 years) emphasized "going deeper" but no with certain ways on how to achieve it:

"The other thing, which I think is also a natural part of KB, [is] focusing, like the questions are just so many; I think we have that balance between the incredible expansiveness of the database and following the kids and for us to go deeper into certain questions. I am still trying to figure out what are the deeper things we could do, rather than stay on the surface of other questions."

Technology

Integrating technology into the day-to-day workings of a classroom represents a challenge for all teachers.   Teachers with limited Knowledge Building experience focus on the technology itself, which can hinder the integration of technology in class; while those with more Knowledge Building experience focus on the use of technology to advance ideas.

"The most challenging issue today is children wanting to speed up and want instant answers. They are doing this because of our media system. Our computers, the Google." (In Premela's interview)

The following example is also from a teacher with <2 year Knowledge Building experience. This teacher has a more sophisticated view of technology, but still viewed Knowledge Building effort and Knowledge Forum (technology) as discrete entities.

"and this year I am looking at how students used it [Knowledge Forum] in the past, their knowledge, or their comfort factor with it. Because I wasn't so comfortable with it, and so I really got a chance just this year to start exploring using KB talk in order to improve the idea in a more formal way." Shared Dorothy.

  Teachers with >5 years Knowledge Building experience conveys a principle-based approach to technology, to sustaining idea diversity, discourse, and knowledge advancement,

"Have adopted many of the innovations of my colleagues by adapting them to suit my classroom. For instance, I changed the scaffolds [Scaffolds are supportive features in the form of sentence starters, such as 'I need to understand', 'my theory', 'new information', for notes, that allow students to engage in theory improvement trajectory] in last year's Knowledge Forum view to reflect the abilities of my students after one of my colleagues suggested that he had done this for his class." (in Clare's interview).

"So this year, the Grade 5, had been with us, how are we going to, and I really waited until it made sense, and then students would say to me, 'can I put it in KF?' I would say, no! that should go... they were surprised that someone they know who uses KF to build knowledge, [would] say that it wasn't necessary, so only this idea of choice, then they were more open to the idea of, it makes sense to use it now; we would be storing a deep question that we can build on. I realize that some of the students who hated it in the beginning, would say, can I write a note in KF so people can build on? So we have to be careful how we use the technology, not for the sake of technology, it has to be for the

sake of knowledge building. Some KB has been in KB Talk, some KB happens in our notebook, and some happened there, I think that is the challenge this year."

Summary

Teachers' responses show that they construct and explore teaching problems along the same lines as skillful teachers engaged with other constructivist pedagogies. Interestingly, as teachers gained more Knowledge Building experience they shifted from a centrist to a relational perspective, as suggested by three core shifts: from focus on obvious or evident features to ill-defined problems, big ideas, and promising possibilities; from routines to adaptive flexibility and novel approaches; and from procedure-based actions to principle-based reflection-in-action. As these teachers gained more experience, they shifted from a centrist to a relational perspective within these spaces, and it was this shift that distinguished their work, not the generation of a new set of problem spaces. Further, evidence for the shift from centrist to relational perspective-- and accordingly, to deeper problem analysis, more adaptive response, and more principled action--was more pronounced as they gained more experience in Knowledge Building pedagogy.

Discussion on teachers' construction of problem spaces.

The study found that, in a Knowledge Building practice, teachers had to find, construct, and reconstruct problem spaces to advance their classroom processes and inquiries. This is unlike the fire-fighting analogy that we often associate with teaching practice.

The study also found that all teachers construct five common problem spaces with different content and details ("content" here refers to nature of the problem space; it does not refer to the different inquiry topics in these three case studies). Each teacher constructed related problem spaces throughout the year, and, interestingly, had not completed the construction of problem spaces even after the year was over. In the final reflection of the year, they admitted that they still did not have a good understanding of the problem spaces they encountered in class, despite having made considerable progress. This suggests that they see themselves on a continuous improvement trajectory.

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