CONCEPTUAL SHIFTS WITHIN PROBLEM SPACES AS A FUNCTION OF YEARS
OF KNOWLEDGE BUILDING EXPERIENCE

By

Chew Lee Teo

A thesis submitted in conformity with the requirements
for the degree of Doctor of Philosophy
Graduate Department of Curriculum, Teaching and Learning
Ontario Institute for Studies in Education
University of Toronto

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Doctor of Philosophy, 2012
Chew Lee Teo
Department of Curriculum, Teaching and Learning
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Abstract

This thesis explores teaching practice as a function of years of experience with Knowledge Building pedagogy, emphasizing teachers’ continual improvement of practice while they foster continual improvement of students’ ideas. Knowledge Building practice places students’ ideas at the centre of the classroom enterprise, with the principal challenge being enabling students to take effective responsibility for improvement of ideas.

Building on a variety of models of teacher thinking and development, a problem space model is developed specifically geared to the development of Knowledge Building practices. This model is used to guide the investigation and provide a theoretically- and empirically-based 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. The principal shift is 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. 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 multiple data sources (teacher meetings, journals, interviews and classroom observations) to analyze the work of 13 teachers over a full school year, with three embedded case studies. 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.
Acknowledgements

To God, for from Him and through Him and for Him are all things.

I am thankful to many who have helped me in this journey. I am especially grateful to:

Marlene. Thank you for your brilliance, energy and generosity and thank you for allowing me to believe in myself.

Elizabeth and David. Your love and continual support gave me the courage to press on. So much can’t be expressed in so few words. Thank you.

Richard, Zoe, Norah, Heather and Carol. Your inspiring classroom work gave me the impetus to work hard to complete this writing so that many more may read and know about your work. Thank you.

And my family. For allowing me to pursue my passion and my dream.
Table of Contents

CHAPTER 1 .......................................................................................................................... 1

CHAPTER 2 .......................................................................................................................... 7

Literature Review .................................................................................................................. 7
2.1 Introduction ..................................................................................................................... 7
2.2 Research on Teachers’ Problem Solving: The Need For Multi-Faceted And Detailed Data .... 7
2.3 Knowledge Building as a Principle-Based Approach to Teaching ................................. 8
2.4 Expertise and Problem Solving ..................................................................................... 20
   2.4.1 Routine and adaptive expertise in teaching ............................................................ 20
2.5 General Theory of Problem Solving .............................................................................. 22
   2.5.1 Generating a problem space .................................................................................. 23
   2.5.1.1 Generating the problem space for different problem types ............................. 22
   2.5.1.2 Types of problems in problem space ............................................................... 24
   2.5.2 Exploring the problem space ............................................................................... 25
   2.5.2.1 Metacognition ............................................................................................... 25
   2.5.2.2 Efficiency and innovation ............................................................................. 25
2.6 Design Considerations ................................................................................................. 26
   2.6.1 Problem spaces in teaching and learning ............................................................. 27
2.7 A Relational View of Problem Spaces for Teaching ...................................................... 31
2.8 Correspondences between skillful teacher, relational, and Knowledge Building problem spaces ................................................................. 34
2.9 Impediments to Relational Work Within Problem Spaces .......................................... 40
2.10 A Centrist to Relational Model of Action in Five Educational Problem Spaces in Advance
   Knowledge Building Practice ......................................................................................... 43

2.11 Summary ..................................................................................................................... 50

Chapter 3 Methodology ........................................................................................................ 53

3.1 Research Approach ........................................................................................................ 53
3.2 Research Design ........................................................................................................... 54
3.3 Data collection

   methods ........................................................................................................................... 55
   3.3.1 Semi-structured interviews .................................................................................. 55
   3.3.2 Observations ........................................................................................................ 56
   3.3.3 Written journal entries ....................................................................................... 57
3.4 Participants .................................................................................................................... 57
CHAPTER 4 Results (Part 2).................................................................................................................. 79
4.1 Case Studies of Three Teachers with Different Levels of Knowledge Building Teaching Experience ...................................................................................................................... 79
4.2 Centrist and Relational Perspectives in Problem Spaces Identified in Interviews with Teachers .................................................................................................................................. 85
4.2.1 Curriculum/standards (Code: C/S) ......................................................................................... 85
4.2.2 Student capability (Code: SC) .............................................................................................. 86
4.2.3 Social interaction (Code: SI) ............................................................................................... 88
4.2.4 Classroom structures and constraints (Code: CS&C) .......................................................... 89
4.2.5 Technology (Code: T) ......................................................................................................... 90
4.3 Understanding Knowledge Building Theory and its Impact on the Construction and Elaboration of Problem Spaces ...................................................................................................................... 91
4.3.1 Teachers’ understanding of Knowledge Building Pedagogy ................................................ 91
4.3.2 Teachers’ reflection on their practice: toward a model of continual improvement .......... 92
4.4 Summary .................................................................................................................................... 93

CHAPTER 5 Results (Part 3).................................................................................................................. 122
5.1 Teachers Operating as a Community to Construct and Explore Problem Spaces Related to Knowledge Building Classroom Practice ......................................................................................................... 122
5.2 Data analysis and coding scheme Teachers’ sequence of actions and decisions .......... 122
CHAPTER 7

7.1 Changes from Centrist to Relational Perspectives within Five Problem Spaces Constructed and Explored by Teachers with Different Levels of Knowledge Building Experience
CHAPTER 1
Introduction

This thesis seeks to explore teaching practice through an analytical, exploratory study, using multiple data sources to uncover problem spaces generated and explored by Knowledge Building teachers with one to eight years of experience, through their daily classroom experiences.

Knowledge Building has been defined as “the production and continual improvement of ideas of value to a community, through means that increase the likelihood that what the community accomplishes will be greater than the sum of individual contributions and part of broader cultural efforts” (Scardamalia & Bereiter, 2003; 2006). Knowledge Building practice places students’ ideas at the centre of the classroom enterprise (Scardamalia & Bereiter, 2003, p. 1370); 12 Knowledge Building principles (Scardamalia, 2002; Scardamalia)—characterize the complex, interactive system, that makes it possible to keep those ideas on a continual improvement trajectory. Knowledge Building is represented in the Cambridge Handbook of the Learning Sciences as one of five foundational approaches within the learning sciences. Throughout the thesis the term Knowledge Building is capitalized to denote this specific approach. There are, of course, many other approaches to knowledge building and when the phrase is used in a more general sense it is not capitalized.

The evolution of knowledge building as a worldwide initiative is reflected in the fact that a web search of the phrase “knowledge building” a decade ago showed fewer than 10,000 entries. In the next five to seven years it reached the level of “knowledge creation”—its more
popular synonym in the business world—at 500,000 entries. It has continued to grow as an area of intense research, keeping pace with its counterpart “knowledge creation” and now shows well over a million links. This growing interest seemingly signals an increasing awareness that “knowledge creation” should not be the province of an intellectual elite, but rather that everyone needs to have a part in a knowledge-creating culture. Giving them a legitimate and rewarding part calls for an expansion of “knowledge creation” to something with more extended roots in contemporary societies, education, and human development. As Scardamalia and Bereiter indicate, knowledge building goes on throughout a knowledge society and is not limited to education. “Ideas at the centre” is its hallmark, but little is known about its precursors and development, or about how teachers engage in Knowledge Building and create the pedagogical advances associated with it. While significant advances are being made (see, for example, a recent special issue of *Canadian Journal of Learning and Teaching on Knowledge Building* edited by Egnatoff & Scardamalia, 2010), there is much work to be done.

Schon’s concept of reflection-in-action, as contrasted with reflection-on-practice (1983) has been widely adopted in education, and as elaborated in this thesis, represents an essential component of an idea-centred classroom. There is little empirical data on this aspect of teachers’ work (Russell & Munby, 1992). 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. Knowledge Building requires continual
decision making as students’ ideas represent a constant source of new information requiring
problem solving to transform the classroom into a community of reflective, knowledge-
advancing members (Brown, 1997; Zhang et al., 2009). In these contexts, 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 aims to “refashion education…so that it becomes a coherent effort
to initiate students into a knowledge-creating culture… students coming to see themselves and
their work as part of the civilization-wide effort to advance knowledge frontiers” (Scardamalia &
Bereiter, 2006, p. 97). Its most distinctive characteristic is giving students collective
responsibility for idea improvement. Of course, any successful educational program will ensure
that the ideas students leave with are an improvement over the ideas they brought in, but in
Knowledge Building all ideas are assumed to be improvable, and the students themselves are
positioned to assume responsibility for advancing them. Engineers and designers do not even
contemplate the possibility of a final state of perfection (Petroski, 2003). Knowledge Building
students and teachers don’t either.

Knowledge Building pedagogy requires principle-based, as opposed to procedure-based,
action. The former requires continual invention and reinvention in light of principles and their
many possible implementations in practice, while the latter is more a matter of executing pre-
planned activities (Zhang et al., 2010). Principle-based action requires adaptive expertise, a form
of “expert knowledge that supports continual learning, improvisation, and expansion” (Bransford
et al., 2006). Bransford et al. (2006) argue that it is important to understand the metacognitive
dimension of adaptive expertise, which requires balancing innovation and efficiency. There is a
strong connection between Knowledge Building practice and adaptive expertise—a connection that is essential for understanding the problems teachers identify as important and the solutions they generate.

Problem space (Newell & Simon, 1972) is 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 thesis 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. The first process breaks down further to include cognitive processes such as finding the problem, constructing the problem, and reflecting on the problem. These problem-solving processes are distinctive for complex and ill-defined design problems, as contrasted with well-structured problems. Typically teachers, along with other problem solvers, oversimplify the situation, to avoid complexity and address the problem in the time available. They mostly react to events that present themselves and require immediate action—such as classroom management and the failure of students to comprehend a curriculum goal. For other pedagogical issues, they tend to make decisions intuitively, without much consideration of “trade-offs” between new possibilities and efficiency (Dillon, 1982; Moore, 1983). 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, then, which comes after the decision is made, is at best an exercise in rationalization rather than deliberate reflection-in-action. Understanding problem
spaces as teachers construct and explore them is essential if we are to encourage reflection-in-action and adaptive expertise in teaching.

The study of teachers’ reflection-in-action in their natural setting is difficult because so many classroom problems are interpreted as well-defined problems within prevailing categories of classroom activity. Knowledge Building practice relies on teachers’ understanding and interpretation of Knowledge Building principles (Scardamalia, 2002) and their translation of these principles into daily practice. The idea of operating as a designer of novel educational possibilities is not only under-represented in studies of teaching practice, it is under-represented in professional development courses. Thus, it is difficult to find contexts in which teachers negotiate meaning with peers regarding their practice and results.

This research takes advantage of a unique context—a school that has adopted Knowledge Building theory, pedagogy, and technology for more than a decade, and where innovative practice has become an integral part of the school’s culture (Bielacyzc & Collins, 2006; Zhang et al., 2009). It thus provides multi-faceted and rich accounts of teaching practices. Data sources include (a) teachers’ Knowledge Building practices in their classroom, sampled over a full school year; (b) negotiated understanding of Knowledge Building practice, as represented in weekly teacher meetings over the same school year, including reflections on their classroom actions; and (c) teachers’ personal reflections, as conveyed in their journals. Using these data sources, it is possible to consider an understanding of Knowledge Building practice as an individual as well as a collective endeavour, and to address features of teachers’ individual and community interaction that make these practices sustainable and more likely to lead to improved classroom practice.
The research questions are as follows:

1. What kinds of problem spaces do Knowledge Building teachers construct and explore?

2. How do individual teachers, as reflected in individual case studies, construct and explore teaching problem spaces related to Knowledge Building practice?

3. How do these teachers, as a community, construct and explore teaching problem spaces related to Knowledge Building classroom practice?
CHAPTER 2

Literature Review

2.1 Introduction

This chapter explores teachers’ problem solving and the adaptive expertise component of this process. Adaptive expertise is necessary to understand the situated nature of teaching practice and how teachers are able to engage in innovative design, bringing the teaching profession closer to the 21st-century educational landscape. This chapter also provides a brief overview of the concept of a problem space, a space for problem solving, with focus on complex and ill-defined design problems of the sort to be elaborated in this thesis and various accounts of teacher problem spaces. The chapter ends with a proposed model to frame the research questions that define the year-long investigation into teaching practices.

2.2 Research on Teachers’ Problem Solving: The Need For Multi-Faceted And Detailed Data

Many cognitive studies convey the importance of investigating individual representations of knowledge as a way to understand how individuals participate in a social setting (Anderson, Reder, & Simon, 1996; Wagner, 1996; Cobb & Bowers, 1999; Chiu, Hsu, & Wang, 2006). Such individual representations of knowledge can be understood from individual responses to stimuli, verbal report, and observed action. A teacher solving problems in the classroom provides an especially important account. When teachers plan or think through lessons, they are thinking through the array of problems that prepare them for interacting with their students, with their peers, with interns, or with other helpers in the class. In addition to understanding individually
represented knowledge, it is also important to take into account how the teachers’ knowledge
develops when interacting with their peers and with their students, both in routine situations and
when faced with new problems (Greeno, 1997). In this case, cognitive and socio-cultural
perspectives are important in accounting for teachers’ knowledge. The need to understand
teacher choices and action from diverse perspectives set the stage for his study, which was
accordingly designed so that data could be collected from an individual cognitive perspective,
from a social perspective, and from a situated perspective.

As indicated in Chapter 1, Knowledge Building pedagogy assumes that teachers can
make a shift from procedure- to principle-based pedagogy. But an isolated activity or single
point of enactment in a principle-based practice may look identical to that of a procedure-based
classroom--e.g. a lesson that involves students testing a hypothesis through experimentation in a
science laboratory could occur in either a principle-based classroom or a procedure-based
classroom. To understand teacher practices and intentions it is essential to get to the reason
behind the laboratory work. For example, did it follow from a student’s formulation of a theory
to be tested, or from an exercise prescribed in a curriculum guideline? In view of the effort to
explore dimensions of teachers’ cognition, and to provide a better accounting of principle-based
pedagogy, as elaborated below, it is essential to understand teachers’ explicit theories of action
and the implicit theories underlying those actions (Argyris & Schon, 1995; Eraut, 2000), as
conveyed in their communal discourse, lesson ideas, classroom events, reflections, and so forth.
Detailed accounts are critical in addressing the immediacy and ongoing nature of teachers’ work,
especially as action unfolds (Aryris, 1995).

2.3 Knowledge Building as a Principle-Based Approach to Teaching
Knowledge Building—the production and continual improvement of ideas of value to a community—focuses on creating an idea-centred classroom where idea improvement is central. The centrality of ideas, in contrast to completion of specific tasks or activities, sets Knowledge Building apart. Of course, students complete tasks and activities, but as indicated above, their primary focus is not on this but on idea improvement. In a Knowledge Building classroom, it is believed that children of all ages can engage in collective knowledge creation activities, and that they can produce new ideas and advance communal knowledge (Bereiter & Scardamalia, 2010; Zhang et al., 2009), taking on the dynamics found in innovative expert communities.

Knowledge Building practice requires teachers to generate opportunistic and inventive procedures derived from principles. This requirement is the defining characteristic of the principle-based approach (Brown & Campione, 1996; Scardamalia & Bereiter, 2007; Zhang, 2010a). In contrast, procedure-based practice relies on scripted routines (ordered lists of learning tasks or activities generally taken from curriculum guidelines). Of course, all educational programs vary in the degree of structure provided. As elaborated in Zhang, Hong, Scardamalia, Teo, and Morley (2011), we can think of these programs as falling along a continuum from procedure- to principle-based approaches. At the procedure-based end of this continuum, innovations are translated into curriculum guidelines that specify procedures to be faithfully implemented. Principles must be inferred from procedures, as the underlying conceptual framework is seldom made explicit. Typically, guidelines provide carefully sequenced activities and pre-established steps, prompts, scripts, and other structuring devices that convey a procedure-based framework. At the principle-based end of the continuum, principles are made explicit and are presented to teachers and students as pedagogical design parameters. The goal is to encourage teachers and students to operate as developers and innovators who continually
invent and improve their practice and the principles, through analysis of the principles and how they play out in their educational contexts. Between these two ends of the continuum, we have principle-based procedures. Here, principles and practices are made explicit in prescribed activities for effective action.

Under the Knowledge Building principle-based approach, teachers develop an understanding of the 12 principles that define this pedagogical model. These principles, including their socio-cognitive and technological dynamics, as elaborated by Scardamalia (2002), are reproduced in Table 2.1. The technological dynamics make reference to Knowledge Forum—software specially developed to support Knowledge Building. Knowledge Forum is a networked, communal electronic platform that allows members to contribute and improve ideas through authoring, build on, annotate, and reference to one another's note. There are also features such as rise-aboves notes that encourage members to summarize, distil and advance the knowledge shared. The ideas, problems, information, and so on are archived and shared in an electronic space on Knowledge Forum called 'a view'. Each view works as electronic workspaces for higher level of organization of ideas and knowledge.

Table 2.1. Socio-Cognitive and Technological Determinants of Knowledge Building
(Scardamalia, 2002)

<table>
<thead>
<tr>
<th>Principles</th>
<th>Socio-cognitive and technological dynamics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real ideas, authentic</td>
<td>Socio-cognitive dynamics: 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</td>
</tr>
</tbody>
</table>
learners really care about—usually very different from textbook problems and puzzles.

*Technological dynamics:* Knowledge Forum creates a culture for creative work with ideas. Notes and views serve as direct reflections of the core work of the organization and of the ideas of its creators.

| Improvable ideas | *Socio-cognitive dynamics:* All ideas are treated as improvable. Participants work continually 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 taking risks—revealing ignorance, voicing half-baked notions, giving and receiving criticism.

*Technological dynamics:* Knowledge Forum supports recursion in all aspects of its design—there is always a higher level, there is always an opportunity to revise. Background operations reflect change: continual improvement, revision, theory refinement.

| Idea diversity | *Socio-cognitive dynamics:* 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.

*Technological dynamics*: Bulletin boards, discussion forums, and so forth provide opportunities for diversity of ideas, but they only weakly support interaction of ideas. In Knowledge Forum, facilities for linking ideas, and for bringing different combinations of ideas together in different notes and views, promote the interaction that makes productive use of diversity.

| Rise above | *Socio-cognitive dynamics*: 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. |

|  |

*Technological dynamics*: In expert Knowledge Building teams, as in Knowledge Forum, the conditions to which people adapt can change as a result of the successes of other people in the environment. Adapting means adapting to a progressive set of conditions that keep raising the bar. Rise-above notes and views support the unlimited embedding of ideas in increasingly
advanced structures, and support emergent rather than fixed
goals.

| **Epistemic agency** | **Socio-cognitive dynamics:** Participants set forth their ideas and negotiate a fit between personal ideas and the 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** | **Socio-cognitive dynamics:** 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. |
Technological dynamics: Knowledge Forum's open, collaborative workspace holds conceptual artifacts that are contributed by community members. Community membership is defined in terms of reading and building on the notes of others, ensuring that views are informative and helpful for the community, linking views in ways that demonstrates interrelationships between views. More generally, the effectiveness of the community is gauged by the extent to which all participants share responsibility for the highest levels of the organization's knowledge work.

Democratizing knowledge

Socio-cognitive dynamics: 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 have/have-not or innovator/non-innovator lines with respect to knowledge. All are empowered to engage in knowledge innovation.

Technological dynamics: There is a way into the central knowledge space for all participants; analytic tools allow participants to assess the evenness of contributions and other indicators of the extent to which all members do their part in a
joint enterprise.

<table>
<thead>
<tr>
<th>Symmetric knowledge advancement</th>
<th>Socio-cognitive dynamics: 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.</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Technological dynamics:</em> Knowledge Forum supports virtual visits and the co-construction of views across teams, both within and between communities. Extended communities serve to embed ideas in increasingly broad social contexts. Symmetry in knowledge work is directly reflected in the flow and reworking of information across the views and across the databases of different teams and communities.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pervasive knowledge building</th>
<th>Socio-cognitive dynamics: Knowledge building is not confined to particular occasions or subjects, but pervades mental life—in and out of school.</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Technological dynamics:</em> Knowledge Forum encourages knowledge building as the central and guiding force of the community's mission, not as an add-on. Contributions to collective resources reflect all aspects of knowledge work.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Constructive uses of</th>
<th>Socio-cognitive dynamics: To know a discipline is to be in touch with both the present state and the growing edge of knowledge in</th>
</tr>
</thead>
</table>
**authoritative sources**

the field. This requires respect and understanding of authoritative sources, combined with a critical stance towards them.

*Technological dynamics:* Knowledge Forum encourages participants to use authoritative sources, along with other information sources, as data for their own knowledge-building and idea-improving processes. Participants are encouraged to contribute new information to central resources, to reference and build on authoritative sources; bibliographies are generated automatically from referenced resources.

<table>
<thead>
<tr>
<th>Knowledge building discourse</th>
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</thead>
</table>
| *Socio-cognitive dynamics:* 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.

*Technological dynamics:* Knowledge Forum supports rich intertextual and inter-team notes and views, and emergent, rather than predetermined, goals and workspaces. Revision, reference, and annotation further encourage participants to identify shared problems and gaps in understanding, and to advance understanding beyond the level of the most knowledgeable individual.
Embedded and transformative assessment

Socio-cognitive dynamics: Assessment is part of the effort to advance knowledge—it is used to identify problems as the work proceeds, and it 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 more rigorous than external assessment, and which serves to ensure that the community’s work will exceed the expectations of external assessors.

Technological dynamics: Standards and benchmarks are objects of discourse in Knowledge Forum, to be annotated, built on, and risen above. Increases in literacy, 21st-century skills, and productivity are by-products of mainline knowledge work, and advance in parallel.

Empirical research has been conducted to define the classroom design and strategies necessary to translate these principles into practice (Table 2.2, Zhang et al., 2009). It is evident in this overview that the principles themselves require work in complex problem spaces.

Table 2.2: Teachers’ Design and Strategies to Support Three Knowledge Building Principles (Zhang et al., 2009)
<table>
<thead>
<tr>
<th><strong>Principle</strong></th>
<th><strong>Supportive Designs and Strategies</strong></th>
</tr>
</thead>
</table>
| Real ideas, authentic problems | - Contributing theories, problems of understanding, and other forms of epistemic artifacts  
- Identifying “big ideas” in the curriculum and in their own contributions  
- Evolving inquiries by revisiting previous work or discussing current events related to student interests (e.g., hurricanes)  
- Generating questions, formulating thematic goals, sharing initial ideas through whole-class discussions, and working collaboratively to improve ideas  
- Monitoring self- and group progress toward understanding and identifying deeper questions and challenges |
| Collective responsibility for community knowledge | - Creating a safe and supportive community that encourages and works with idea diversity  
- Discussing and highlighting social norms that support knowledge building (e.g., respect, careful listening, detailed accounts, building on rather than repeating what others have said)  
- Co-creating mission statements and goals; linking views (workspaces) in Knowledge Forum to convey interrelated knowledge goals; and using background pictures to |
highlight themes and advances

- Cross-referencing ideas; engaging in incremental building on; connecting current work with ideas and information in the community space (e.g., discussion notes, experimental findings, insights from readings)

- Using dynamic social structures that integrate whole-class discussions, small-group reading and experiments, and individual work, encouraging students to group and regroup based on evolving needs

- Reviewing progress as a community, sharing insights, generating excitement, and identifying new problems of understanding

<table>
<thead>
<tr>
<th>Constructive use of authoritative sources</th>
<th>Highlighting questions and discussing initial ideas before students read material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Engaging in small-group cooperative reading of difficult texts</td>
</tr>
<tr>
<td></td>
<td>Coaching and using strategies of deep reading (e.g., questioning, reviewing, summarizing). Sharing important information from readings in Knowledge Forum and going beyond given information</td>
</tr>
<tr>
<td></td>
<td>Collectively developing an online glossary to help community members understand the related key concepts</td>
</tr>
</tbody>
</table>
It is through teachers’ efforts to apply these principles, and through reflection on their classroom practices in light of them that we explore this principle-based approach. The work that a Knowledge Building teacher needs to engage in is analogous to the work of an engineer designing a bridge based on the laws of physics. The engineer first must gain sufficient understanding of the laws that govern the physical world, and apply them to his or her design so that the bridge can function in the intended manner. The engineer cannot alter or influence physical phenomena, but understanding of the laws of physics can help him or her anticipate unwanted outcomes, improve designs, and optimize the physical phenomena explained by these laws. To meet the demands of Knowledge Building practice, teachers must continually design and redesign learning and teaching activities, and reformulate classroom procedures, to support idea advancement, which is the fundamental principle of Knowledge Building (Scardamalia & Bereiter, 2006). Innovating teaching approaches is an essential dimension of this focus on idea advancement (Bereiter & Scardamalia, 2006).

2.4 Expertise and Problem Solving

This section examines the concept of adaptive expertise and the impact it has on problem solving, especially in teaching and learning.

2.4.1 Routine and adaptive expertise in teaching.

In his seminal work on adaptive expertise, Hatano (1982) postulates three factors that differentiate adaptive and routine expertise. They are (i) Nature of object: A built-in randomness of the task at hand would motivate the person to revise the original skill because the original skill
might not be relevant this time around. This “repeat application of the procedure with variations is likely to lead to development of adaptive expertise”; (ii) Degree of understanding: If the culture requires one to understand systems and explain skills, in addition to requiring quick responses and timely performance, then there is a tendency to develop adaptive expertise. (iii) Context of the task: If there is no formal evaluation of the performance, one tends to be more open to “active experiment” and there are more chances to develop adaptive expertise.

Such factors must be explored in relation to innovative teaching practices, as an innovative teacher’s adaptive expertise would enable him or her to expand his or her core competencies according to the arising needs and interests of students, and to take on the role of “intelligent novice” to explore new knowledge with their students (Bransford et al., 2006). In short, innovative teaching practices require adaptive expertise.

Adaptive experts differ significantly from those who adopt fixed routines. Adaptive experts rely on conceptual knowledge of the problem (Hatano & Inagaki, 1986) to generate better problem representations—representations that contain the problem’s deep features and abstract concepts rather than surface feature and formulae (Chi, Feltovich, & Glaser, 1981). When exploring a problem space, adaptive experts engage in lengthy reasoning about alternative solutions, especially when working within a problem space that is unfamiliar (Ericsson & Hastir, 1994). With respect to expertise in teaching, a teacher normally responds to immediate teaching problems or classroom issues (Shamin, 1996), such as how to regroup students to deal with low participation. On a larger scale, teachers sometimes need to adopt an intervention mandated for the school, such as a new mode of online assessment that makes use of new technology (Zhao et al., 2002). Research suggests that teachers often lack the conceptual understanding needed to successfully adopt a pedagogical reform, or to translate it into something that will make it
possible to improve students’ learning; and that instead they focus narrowly on specific content (Noss & Hoyles, 1996). From an adaptive expertise perspective, such choices reflect a preference for efficiency over innovativeness. Thus, the way the teacher defines and manages the classroom serves to block the innovation—as opposed to the efforts to reconstruct practice in light of a deeper understanding of the principles underlying it, and a more open, exploratory approach. Over-reliance on routines can block the forms of innovation that occur in creative enterprises such as architectural design (Schon, 1996). Similarly, an over-reliance on classroom routines and management has the effect of limiting variation. A variation of approach is necessary to develop adaptive expertise of the sort that characterizes scientific work (Dunbar, 2000); it also characterizes artistic and intuitive processes that practitioners need in “situations of uncertainty, instability, uniqueness, and value conflict” (Schon, 1983, p.49).

2.5 General Theory of Problem Solving

Problem solving includes the following three cognitive activities: (i) information processing system; (ii) task environment; (iii) problem space (Simon, 1972). This section focuses on item (iii), the problem space aspect, reviewing the theory of problem space as a way to understand teachers’ problem solving processes.

A problem space reflects “the way a particular subject represents a task in order to work on it” (Simon, 1984). A problem space comprises two major processes: (i) generating the problem space, and (ii) search within the space.
2.5.1 Generating a problem space.

2.5.1.1 Generating the problem space for different problem types.

The theory of problem space emerged from research in human information processing theory (Newell & Simon, 1972). Its key characteristic was the problem’s clear initial state and its final goal. As such, it has been criticized for its limitations in applying to complex real-life issues (VanLehn, 1989). However, a resolution to this dilemma was presented by Simon (1973) when he showed how a more complex problem, like a design problem, can be broken down into smaller problems that can then be solved in a conventional problem space. However, the complexities of many real-world problems require more than breaking them down into smaller parts, as Middleton (1998) argued is the case when solving design problems. Middleton (2000) further explores the concept of problem zones, search and construction zones, and satisficing zones, which better addresses problem spaces for design problems. The metaphor of a problem zone suggests that the problem solver may not have sufficient information or understanding to accurately represent the problem. The kind of problems teachers face in Knowledge Building classrooms are similar to design problems (Zhang et al., 2009). When teaching problems in Knowledge Building classrooms are broken down into components, they can be analyzed with types of problem space analyses similar to those used for conventional classrooms, so that differences can be identified. That is, problems can be conceptualized broadly as requiring construction and exploration strategies to achieve a solution, with various ways of tracking uncertainty regarding suitable solutions.
2.5.1.2 Types of problems in problem space.

Research suggests that different kind of problems require different work. For example, Csikszentmihalyi and Sawyer (1995a) defined two types: (a) regular work in a specific field; and (b) discovered problems, in which the person asks questions and formulates problems that others have not explored.

Dillon (1982) distinguishes between existent/evident, emergent/implicit, and potential/inchoate problems. An existent problem is one that is obvious, with a clear problematic situation—one that can be probed for information and solved readily. An emergent problem has an implicit rather than an explicit problem framework. The solver has to interpret the problem through studying and probing the data and working out elements of a possible solution. Potential problems exist in unformed, interesting situations and ideas worth elaborating. The solver has to put together different elements and invent a problem where none previously existed. Potential problems are most clearly seen in the invention process. This conceptual scheme for problem finding proposed by Dillon (1982) provides clear distinctions among types of problems, and the latter form (i.e., potential problems), is deemed to be necessary in creative processes (Kay, 1991). In summary, these problem types correspond to the various levels of cognitive activities: (i) The existing/evident problem requires recognizing the superficial features of the problem; (ii) the emergent/implicit problem requires discovering the problem through interpreting and probing of data; and (iii) the potential/inchoate problem requires inventing the problem in new ways. (Dillon, 1982).
2.5.2 Exploring the problem space.

The scope of the problems and the manner in which teachers manage or resolve it are further explored in the following section, with attention to how exploration of the problem space affects a teacher’s decisions and actions.

2.5.2.1 Metacognition.

Bransford et al. (2006) present arguments for the importance of a metacognitive function to allow the “adaptive expert” to actively design and structure the learning environment, and to balance innovation (new and better ways of doing things) and efficiency (well-practiced routines). Reflection-in-action fosters this metacognitive function that, in turn, influences classroom actions and decisions. This metacognition dimension is not necessarily natural and common to all teachers, and it is significant because it influences how teachers define problems; how they decide what can or will be done about problems; and, more important, how they manage the consequences of the chosen action over time (Clark & Lampert, 1986).

2.5.2.2 Efficiency and innovation.

Darling-Hammond (1997) note that “[E]ffective teaching is not routine, students are not passive, and questions of practice are not simple, predictable, or standardized. Consequently, instructional decisions cannot be formulated and then packaged and handed down to teachers” (p. 67). Teachers need to appropriate and deepen the underlying principles (Brown & Campione, 1996; Coburn, 2003), develop and improvise classroom procedures (Barab & Luehmann, 2003; Brown & Edelson, 2001; Sawyer, 2004), and address emergent challenges by creating knowledge spontaneously (Lampert, 1999). Teachers need to move from time-efficiency routines to adaptive routines. This design capacity of teaching and learning allows teachers to move beyond procedural and routine expertise (Nonaka, 2002).
According to Zhang et al. (2009) exploration of the problem space can be supported by innovative professional communities that encourage: (a) teachers’ continual learning, deliberate investigation and experimentation, risk-taking, and reflection on enactment (Hargreaves, 1999; Krajcik, Blumenfeld, Marx, & Soloway, 1994; Rogers, 2002; Wilson & Berne, 1999); (b) collaboration and sharing in practice, collegial dialogues about student learning, and friendly critiques (Darling-Hammond, & McLaughlin, 1995; Fogleman, Fishman, & Krajcik, 2006); and (c) teacher professional autonomy (Vescio, Rossa, & Adamsa, 2008). In the next section, we consider how creative capacities, reflection, and effective teaching play out in different problem-solving contexts.

2.6 Design Considerations

In the field of scientific problem solving, Dunbar (1993) and Klahr and Dunbar (1988) use a dual design space—the hypothesis space and the experiment space—to explain how expert scientists reason in their laboratory work to attain scientific advancement. This theory posits that scientists must master two interrelated skills: “knowing where to look and understanding what is seen” (Dunbar, 1993). These skills are necessary for making scientific discoveries. The construction of the problem space makes up teachers’ implicit theories of classroom practice which may deviate considerably from teachers’ espoused theories of their practice (Nesbett & Wilson, 1977). Accordingly, to understand the problem space for design it is important to analyze classroom actions as well as teachers’ explicit explanations of their practice.

Since Knowledge Building places students’ ideas at the centre of classroom practice, and there are always new and changing ideas, this idea-centred approach heightens the importance of the teacher’s attention to accumulated information such as students’ responses over time. It also
requires that teachers identify patterns over time with different students. This creates a fluid problem space with an underlying structure similar to that found with design tasks in different domains where it is essential to address new and changing ideas.

### 2.6.1 Problem spaces in teaching and learning

Saphire et al. (2006,) present a Skillful Teacher model and four main problem areas: classroom management, instructional strategies, curriculum planning, and motivating students (see Table 2.3) that a good teacher has to negotiate before and during lessons. These are then translated into 21 decisions that a “skillful” teacher needs to address when planning and conducting an efficient and effective lesson. Planning in this case refers to implicit planning (teachers running through plans in their heads) as well as written plans.

From the perspective of this thesis, the problem areas set out in Table 2.3 convey what we might think of as classic problem spaces and decision-making parameters for teaching. The challenges focus on management, effective delivery, and engagement of students in meeting curriculum and teacher objectives. As suggested by the pedagogical decisions to be made in the Skillful Teacher model, the effort focuses more on procedures to be implemented, unlike the principle-based decisions required for students to become knowledge builders. Thus, for example, there is concern with building a sense of responsibility and ownership, but not the challenge of turning high-level controls to students, as required to give students epistemic agency—one of the knowledge building principles. This principle requires that the students themselves “deal with problems of goals, motivation, evaluation, and long-range planning that are normally left to teachers or managers.”
Table 2.3: Description of the Mapping Between Teachers’ Pedagogical Decisions and Four Core Problem Areas Identified in The Skillful Teacher Model (Saphier, Haley-Speca, Gower, 2006)

<table>
<thead>
<tr>
<th>Four main problem spaces</th>
<th>Pedagogical decisions in a regular classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom management</td>
<td>Space and time: Teacher concerned with arranging the classroom to get the most of classroom space and the control of time.</td>
</tr>
<tr>
<td></td>
<td>Routine: Teacher concerned with procedural routines that are important, and about maximizing the effectiveness of these routines.</td>
</tr>
<tr>
<td></td>
<td>Attention: Teacher concerned with ways to get students to pay attention and stay on task.</td>
</tr>
<tr>
<td></td>
<td>Discipline: Teacher concerned with ways to eliminate disruptions while building responsibility and ownership.</td>
</tr>
<tr>
<td></td>
<td>Momentum: Teacher concerned with keeping the flow of events going, ensuring that the events move smoothly and minimizing downtime.</td>
</tr>
<tr>
<td>Determining instructional strategies</td>
<td>Clarity: Teacher concerned with making concepts and skills clear and accessible to students.</td>
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<td>------------------------------------</td>
<td>--------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Principle of learning: Teacher concerned with efficiency and effectiveness of learning experiences.</td>
</tr>
<tr>
<td></td>
<td>Model of teaching: Teacher concerned about creating learning experiences that develop the mind as well as the content.</td>
</tr>
<tr>
<td>Ensuring students are motivated</td>
<td>Classroom climate: Teacher concerned about ways to build a climate of inclusion, risk-taking, and personal efficacy.</td>
</tr>
<tr>
<td></td>
<td>Expectations: Teacher concerned with ways to communicate to the students the importance of what the class is doing.</td>
</tr>
<tr>
<td></td>
<td>Personal relationship building: Teacher concerned about building good personal relationships with students and making them feel truly known and valued. delays and distractions.</td>
</tr>
<tr>
<td>Curriculum planning</td>
<td><strong>Objectives</strong>: Teacher concerned about framing the objectives so that they can provide precise guides to his/her planning and his/her students’ learning.</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Curriculum design</strong>: Teacher concerned with the curriculum content and how much s/he knows of the curriculum.</td>
<td></td>
</tr>
<tr>
<td><strong>Learning experience</strong>: Teacher concerned about creating differentiated learning experiences for students.</td>
<td></td>
</tr>
<tr>
<td><strong>Planning</strong>: Teacher concerned with how to plan the lesson so that it reaches out to all students.</td>
<td></td>
</tr>
<tr>
<td><strong>Assessment</strong>: Teacher concerned with the use of assessment to improve students’ performance and inform his/her own instruction.</td>
<td></td>
</tr>
<tr>
<td><strong>Planning</strong>: Teacher concerned with the ways s/he can plan the lesson to reach out to all students.</td>
<td></td>
</tr>
<tr>
<td><strong>Overarching objectives</strong>: Teacher attempting to bridge personal passion about education to the bigger educational goal (usually stated by government departments or ministries of education--e.g., the No Child Left Behind policy in the US, or the C2015 -- developing four core 21st-century competencies among students -- in Singapore).</td>
<td></td>
</tr>
</tbody>
</table>
2.7 A Relational View of Problem Spaces for Teaching

Lampert (2001) uses relationships among teachers and various aspects of teaching and learning to characterize teaching and learning problem spaces (Figure 2.1). According to Lampert (2001), teaching actions proceed simultaneously in relations with students, with content, and with the connections between students and content.

Figure 2.1: Four problem spaces of teaching practice defined by relationships between teacher-student; teacher-content; teacher–(student-content) as described by Lampert (2001).

This relationship is a “problem space” in the work of teaching. Working along the practice arrow that connects my work with my students, I can use them as a resource to solve the problems of my practice. They can also constrain my actions and hinder my efforts to support their learning. (p. 31)
Figure 2.1.: Relational View of Problem Spaces (Lampert, 2001)
Building on Lampert’s (2001) depiction of teaching problems and their problem space, the literature has broadly categorized four sets of problem spaces in which a teacher negotiates daily work (Yinger, 1980; Brown, 1997; Connelly & Clandinin, 1997; Bielaczyc, 2006; Darling-Hammond, 2005; Saphier et al., 2007). A summary of the synthesized problem space in a classroom which represents a relational view of problem space is as follows:

i. A problem space defined by teacher problem solving in relation to classroom events and relationships between teacher and students (Trigwell, Prosser, & Waterhouse, 1999; Pang & Marton, 2005).

ii. A problem space defined by teacher problem solving in relation to policies on content, the curriculum, and standards or expectations (Remillard, 2005; Ball, Thames, & Phelps, 2011). In this context, the problems teachers need to address, and the resources for solving them, are often connected to issues on assessment of learning.

iii. A problem space defined by teacher problem solving in relation to managing learning outcomes and the relationship between teacher, student, and content. Because of the rapid development of the learning sciences over the past two decades, this aspect of teaching has expanded to incorporate a broad range of activities, including teachers ensuring an active interaction between students and their learning environment; teachers translating learning theories into practice (McLaughlin & Mitra, 2000; Zhang et al., 2010); and teachers considering metacognition dimensions of teaching and learning (De Corte, 2000). This is also closest to what Schulman (1987) refers to as teachers’ content-pedagogical knowledge.
iv. **Teacher problem solving defined by relationship among peers.** This includes teachers’ roles in professional communities (McLaughlin & Talbert, 2010; Scardamalia, 2002; Zhang et al., 2009) and emerging professional developmental needs (Cochran-Smith & Lytle, 2009).

### 2.8 Correspondences between skillful teacher, relational, and Knowledge Building problem spaces

We propose that Knowledge Building practice is only possible when a teacher develops an understanding of the 12 principles that define this pedagogical model, and deep understanding requires a relational perspective. The relational model is broad in scope and conveys well-known classroom problem spaces, and the knowledge building principles require a relational perspective, so an attempt was made to map the socio-cognitive and technological dynamics of these principles onto the relational model. Toward this end designs and strategies as set out by Zhang et al., 2009 and elaborated in Table 2.2 were used to explore the problem spaces that teachers have to construct and explore to bring about idea-centred pedagogy. Table 2.4 shows how knowledge building principles can be mapped onto the relational perspective.
Table 2.4: Teachers’ Design and Strategies to Support Knowledge Building Principles

<table>
<thead>
<tr>
<th>Principles for design and strategies in a Knowledge Building Classroom (Scardamalia, 2002; Zhang et al., 2009)</th>
<th>Relational problem spaces</th>
</tr>
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<tbody>
<tr>
<td><strong>Real and authentic ideas:</strong> Teacher supports students in identifying problems that arise from students’ efforts to understand the world, and creates opportunities for students to pursue sustained creative work surrounding these problems.</td>
<td></td>
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<tr>
<td><strong>Collective responsibility for community knowledge:</strong> Teacher creates a learning environment where all students are legitimate contributors to the collective goals of the class; where their ideas are valued and they then take high-level responsibility for advancing the collective knowledge of the entire class, not just for their individual learning. These principles can be translated into practice by first viewing and maintaining the relationship between teacher and students differently: i.e., what guides the way in which the teacher supports, understands and builds relationships with his/her students?</td>
<td></td>
</tr>
</tbody>
</table>
**Democratizing knowledge:** Teacher empowers all students as legitimate contributors to the shared goals, so that all take pride in knowledge advances of the community. Teacher promotes a culture where diversity and differences are viewed as strengths, rather than as leading to separation along have/have-not lines with respect to knowledge.

**Symmetric knowledge advance:** acknowledging that expertise is distributed within and between communities and team members

These problem space in which teacher construct and explore in includes:

(i) Managing social interaction

(ii) Building students’ capability

(iii) Creating conducive environment (physical space and technological space) for (i) and (ii)

(iv) Using classroom structures and overcoming constraints
Improvable ideas: Teacher treats ideas as improvable, rather than as simply accepted or rejected, so students continue to work on their ideas to improve the explanatory power, coherence, and utility of ideas.

Idea diversity: Teacher helps students to understand that knowledge advancement depends on the diversity of ideas. Teacher helps students identify and bring related ideas together, including those that stand in contrast to each other, to help improve their understanding of an idea.

These principles can be translated into practice by first reviewing the relationship between teacher and content differently: what guides the ways in which the teacher works with the content, the school curriculum?
Constructive use of authoritative sources: teacher and students access and critically evaluate authoritative sources, and use them to support and refine their ideas, not just to find “the answer.”

Pervasive Knowledge Building: teacher opening up the inquiry space, acknowledging that knowledge building is not confined to particular occasions or subjects but pervades mental life – in and out of school and across contexts.

Knowledge Building discourse: teacher and students engage in discursive practices that not only share but transform and advance knowledge, with problems progressively identified and addressed, and new conceptualizations built.

The problem space in which the teacher constructs and explores includes:

(i) managing curriculum goals and standards
(ii) building students’ capability
(iii) making use of school structures and overcoming constraints
**Rise above:** teacher allows students to work with diverse ideas in complex problem spaces; they transcend trivialities and oversimplifications, and work toward more inclusive principles and higher-level formulations of problems.

**Epistemic agency:** students set goals, assess their work, engage in long-range planning, monitor idea coherence, use contrasting ideas to spark and sustain knowledge advancement, and engage in high-level knowledge work normally left to the teacher.

**Embedded and transformative assessment:** teacher designs and make use of assessment as a way to advance knowledge through identifying advances, problems, and gaps as work proceeds.

These principles can be translated into practice by reviewing the relationship between the teacher and the student-content relationship: i.e., what guides the way in which teachers manage learning outcomes, expectations of students, and assessment?

(i) assessing and managing students’ capabilities

(ii) creating a conducive environment (physical space and technological space) for (i) and (ii)

(iii) making use of classroom structures and overcoming constraints

(iv) ensuring availability of information and resources in environment
This relational model/knowledge-building principles mapping suggested the possibility of a further mapping onto the skillful model problem spaces presented in Table 2.3, as all of these pedagogical models deal broadly with curriculum/standards, interaction patterns between peers-teacher -student, classroom structures and management, and student characteristics as they bear on matters such as inclusiveness and individual differences. The goal in identifying a limited set of problem spaces that span these models and that enable an exhaustive classification of work within and between them is to create a coherent framework for reviewing problems teachers identify and explore in different pedagogical models. The goal is to test the possibility that what distinguishes teachers is not so much the type of problems they explore, but the way they approach the problem. The following five problem spaces represent the limited set identified for use in this study: Curriculum/Standards, Student Capability, Social Interaction, Classroom Structures and Constraints, and Technology. The first four have substantial overlap with the skillful teacher and relational models. The fifth, technology, is an emergent problem space in education and important within the Knowledge Building framework. The matter of how teachers work within these problem spaces are elaborated below.

2.9 Impediments to Relational Work Within Problem Spaces

Work in problem spaces includes: (a) generating the problem and (b) exploring the problem space (formulating strategies). Several factors that impede design-work in problem spaces are considered below as a prelude to the presentation of a problem space model specifically geared to the development of Knowledge Building practices. This model is used to frame this thesis research aimed at showing how teachers overcome these impediments. These impediments include:
i. Treating problem spaces in isolation. A relational or system approach engages teachers in working within a complex, dynamic system. But typically problems spaces are treated in isolation; that seldom works when the goal is that of getting to big idea, generating novel solutions, and so forth. For example, if a child raises an unusual idea the teacher may signal it is not important by continuing with the original conversation. Obviously the teacher is more concerned about reaching lesson goals than with the “relationship with students” or “students’ thinking” underlying a relational goal. Alternatively, the teacher may choose to probe further into the child’s reasoning, thus bringing new dynamics to both the relationship with students and the students’ thinking, as well as completing the lesson or curriculum coverage. The latter choice is more in line with the dual-space theory and a relational perspective.

ii. Time constraints leading to routinization (as opposed to adaptive flexibility, which involves finding new ways to save time while exploring innovative solutions). When teachers feel the need to provide quick responses, there is usually no time for careful deliberation. They quickly rely on intuitive responses based on past experience, leading to routinization and overlooking various stages of problem solving (Eraut, 2000). The contrasting approach, which we aim to explore in this thesis, is more analytical, intuitive, and deliberative reflection-in-action.

iii. Personal rationalizations of practice (as opposed to making choices explicit and making them objects of discussion, to serve as a basis for advancing practice). According to Lampert (2001), because teachers must face the consequences of their actions every day, the problem space they create tends to rely heavily on personal
rationalization—i.e., their implicit theories of action—\(\text{a tendency that Schon (1983) explains as follows:}
In real world practice, problems do not present themselves to the practitioner as givens. They must be constructed from the materials or problematic situations that are puzzling, troubling and uncertain. When we set the problem, we select what we will treat as the things of the situation, we set the boundaries of our attention to it, and we impose upon it a coherence which allows us to say what is wrong and in what directions the situation needs to be changed. Problem setting is a process in which, interactively, we name the things to which we will attend and frame the context in which we will attend to them. (Schon, 1983, p.40)

A meta-analysis of research conducted by Duschl and Wright (1989) provides a more detailed analysis of factors that influence personal rationalization among teachers:

i. Teachers construct models of reality (solutions to their problem space) based on select components of their environment, which then become the basis for their decisions. Their planning and decision-making then focuses on the selection of content and instructional contexts.

ii. Teachers do not teach toward objectives; rather, teachers teach to the instructional activity and treat the activity as the basic unit of planning.

iii. Teachers’ thinking and behaviors are guided by a set of organized beliefs and are, in turn, influenced by the organized beliefs that exist in the social context in which the teacher functions. Consciously or unconsciously, teachers make decisions that affect their behavior.
In view of all these factors, impediments to relational work within problem spaces may be due to teachers’ belief systems, personal preferences, and natural inclinations. It is important to understand teachers’ espoused and implicit theories of action, and to see how creating more open contexts for making these explicit and treating them as objects of discussion can advance their practice.

2.10 A Centrist to Relational Model of Action in Five Educational Problem Spaces in Advance Knowledge Building Practice

The review of problem spaces and dynamics surrounding Knowledge Building practice indicate important factors to be taken into account—factors that would affect work within the problem space. For example, the literature reviewed suggests that approaches to work in a problem space would be dramatically different depending on the extent to which the teacher constructed and explored the problem space. Three shifts are suggested by the literature: (a) Surface to Deep: from focus on obvious or evident features to ill-defined problems, big ideas, and promising possibilities; (b) Routine to Adaptive: from routines to adaptive flexibility and novel approaches; and (c) Procedure-Based to Principle-Based: from procedure-based actions to principle-based reflection in action.

A difference regarding work in problem spaces is reflected in differences between the skillful model of teaching and the relational approach. We see in this a shift from what might be termed a centrist to relational perspective. Underlying the centrist perspective is a belief in established procedures and goals typically understood to characterize effective teaching. The centrist perspective, as conveyed in the Skillful teacher model, is reflected in the teacher’s construction and elaboration of a problem space based on the assumption that significant
classroom work and knowledge advances require establishing effective guidelines, prescriptions, social interaction patterns, curriculum goals and benchmarks, or implementation of other “best practices” that the skillful teacher is known to use. Underlying the relational perspective in the Knowledge Building approach 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 relational perspective is reflected in the teacher’s construction and elaboration of a problem space that reflects a need for re-invention of procedures, routines, and practices in light of student input--input that teachers encourage and respect. This requires working with emergent rather than fixed goals and requires continual improvisation surrounding teacher plans to emerge and to align with ever-changing student ideas and input. This relational perspective accordingly requires continual reworking of plans and procedures to go beyond best practice. This relational approach is viewed as essential for pedagogical models able to foster knowledge building trajectories for “learning lives” –learning spanning contexts and embracing expansive discourses, new media, and social networks. As Erstad and colleagues argue, connecting knowledge between different contexts and activity systems is fundamentally a relational challenge (Erstad, 2011; Erstad, Gilie, Sefton-Green, & Vasbo, 2009).

Building on a variety of models of teacher thinking and development, a problem space model is developed and tested in this thesis specifically geared to the development of Knowledge Building practices. This model posits three pedagogical shifts resulting from advancement from centrist to relational perspectives in each of the five problem spaces: Curriculum/Standards, Social Interaction, Student Capability, Classroom Structures and Constraints, and Technology. Table 2.5 provides an overview of the shifts accompanying each problem space.
Table 2.5 Three Pedagogical Shifts Resulting from Advancement from Centrist and Relational Perspectives in the Five Problem Spaces

<table>
<thead>
<tr>
<th>Surface to Deep:</th>
<th>Routine to Adaptive:</th>
<th>Principle-Based:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advancing from a Central (C) to Relational (R) perspective involves a shift from focus on obvious or evident features to ill-defined problems, big ideas, and promising possibilities</td>
<td>Advancing from a Central (C) to Relational (R) perspective involves a shift from routines to adaptive flexibility and novel approaches</td>
<td>Advancing from a Central (C) to Relational (R) perspective involves a shift from procedure-based actions to principle-based reflection in action</td>
</tr>
</tbody>
</table>

**Curriculum/Standards (C/S)**

| From predetermined, fixed curriculum content and topic analysis to deeper, more expansive analysis of big ideas and promising possibilities in light of students’ ideas | From use of curriculum scripts to integration of students’ ideas to support more flexible and novel approaches. | From sequenced activities and procedures embedded in curriculum guidelines to Work with principles to invent new, adaptive practices to advance curricular goals and student ideas |
### Student Capability (SC)

| From attributing difficulties to lack of student capability to engagement of all participants in advancing shared goals | From individual differences and segregation to democratization of knowledge with student contributions leading to a whole greater than the sum of parts | From use of fixed-stage developmental sequences and benchmarks to turning over increasingly high levels of agency to students so they can exceed expectations. |

### Social Interaction (SI)

| From social interaction to get to know each other to social interaction as a sustaining force for exploration of complex, ill-defined problem spaces, big ideas and new possibilities. | From focus on activities and grouping arrangements to supports for distributed expertise and opportunistic processes that foster emergence of new ideas | From use of procedures and social media for information sharing to design and use of new forms of social interaction to maximize idea improvement |

### Classroom Structures and Constraints (CS&C)

| From viewing time, assessment, class size as structures and constraints | From small group work and divided responsibility for a finished product to structures and constraints | From meaningful activities that fit within classroom structures and constraints |
that limit possibilities to viewing them as boundary conditions that need to be crossed to explore new possibilities flexible roles and systems of support to allow participants to go where their ideas take them. to supportive, organic, and flexible structures that encourage participatory and distributed control and emergent collaboration

Technology (T)

| From familiarity with and ability to use common applications, functions, and web resources to ICT integral to daily work with all participants contributing to and continually advancing shared goals. | From use of technology for standard procedures and administrative convenience to reinventing classroom procedures based on special affordances of new media | From use of technology to implement best practices to combining principles, technology, and analytic tools to provide mutually supportive contexts for continually advancing high-level knowledge processes extensible to real-world contexts |

The model is represented graphically in Figures 2a-2c and used to guide the investigation and provide a theoretically- and empirically-based description of shifts teachers undergo as they gain skill in Knowledge Building pedagogy. The model also guides data analyses from teacher interviews, journal entries, contributions to weekly teacher meetings, and classroom
observations, and serves to convey how Knowledge Building teachers differ from other skillful teachers. As these figures indicate, the principal shift is from a centrist to relational (or systemic) perspective in each problem space.

Figure 2a. Centrist to Relational Perspective Underlying Pedagogical Shift from Surface to Deep Features of Problems in Five Problem Spaces.
Figure 2b. Centrist to Relational Perspective Underlying Pedagogical Shift from Routine to Adaptive Approaches in Five Problem Spaces.
Figure 2c. Centrist to Relational Perspective Underlying Pedagogical Shift from Procedure-based to Principle-based Reflection in Five Problem Spaces.

2.11 Summary

Extensive data collection and analysis are used to provide understanding of teachers’ implicit and explicit understandings of Knowledge Building principles and how they apply these principles in their daily work. This research explores variations in this understanding among teachers with different years of experience within a community committed to advancing Knowledge Building pedagogy. This research is important to better understand Knowledge
Building principles and also to understand the potential for sustained classroom innovation and ways to close persistent gaps between theory and practice.

In an effort to understand the developmental trajectory of teachers’ problem spaces the thesis adopts a multiple-data source, multiple-individual approach. Over a period of a year the researcher conducted interviews with teachers, followed all teachers through select classes and weekly teachers’ community meetings, and traced the enactment of classroom design of three case studies within the communities to reveal connections between the individual and community levels of practice. The research focused on their classroom work, communal discourse in teacher meetings, and reflective entries in journals. These various data sources 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.

A problem space model is developed specifically geared to the development of Knowledge Building practices and used to guide the investigation 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.

A practical purpose of this research is to provide an account of Knowledge Building practice as it is understood in relation to educational innovation (see Collin and Bielaczyc, 2006;
Zhang et al., 2009) and to elaborate the centrist to relational model. The research considered principle-based practice as an emerging problem space, making it possible to see and support professional development teachers need to incorporate a more relational perspective in their daily practice.
Chapter 3
Methodology

3.1 Research Approach

The research used a qualitative approach, adopting the design of a single case study with embedded unit (Creswell, 1992; Yin, 2003). The key characteristics of such an inquiry, and their implications for the research design, are as follows (LeCompte & Preissle, 1993; Lincoln & Guba, 1985; Patton, 1990).

i. Inductive: The analysis of this inquiry is inductive in nature such that the meaning of the educational setting in the study is revealed through interpretative processes of inference where tacit knowledge is involved. Thus, thick description is critical to achieve fair representation.

ii. Context-bound: Data are dependent on context. The context has important implications for the constructed meaning; thus, purposive sampling is needed to capture the full scope of the issues under study.

iii. Dynamic: Realities can be dynamic and emergent and must be constructed through multiple data sources and multiple embedded units to achieve as complete a picture as possible. Thus, the research design must be flexible to capture the necessary data.

This research shared these characteristics in the following ways. First, this study uses an ethnographic method to determine how a group of Knowledge Building teachers construct and interpret various aspects of their practice in their daily routine in their actual school setting, where the researcher cannot determine the classroom events. According to the literature, expert
teachers normally do not write down their planning; they tend to perform mental planning outside of formal planning times (Borko & Livingston, 1989). Thus, it is important for the study to capture all related planning activities in the typical day of a teacher, in order to capture meaningful data.

The study was inductive in that the analysis allowed for emerging codes with close reference to existing problem spaces, and also allowed the opportunity to explore emergent, new problem spaces, if the proposed scheme needed to be expanded. The analysis began by studying the responses of teachers based on their years of teaching experience and years of experience as Knowledge Building teachers. Teachers were divided roughly into novices and experts. However, as the analysis unfolded, a further division was formulated to explore significant differences between teachers within the “expert” group. Further, there was a substantial overlap between years of teaching experience and years of Knowledge Building experience. As elaborated below in the participants section, analyses were finally based on years of Knowledge Building experience.

Methods of data collection and analysis were constantly reviewed, and the researcher was mindful of her influence on the context. Detailed descriptions are enabled through the use of a flexible design, alternating between analysis and review, and based on rich, multi-faceted data sources.

3.2 Research Design

This research explores teachers’ perspectives on, and enactment of, Knowledge Building pedagogy, within the bounded system of a real classroom environment, teachers’ meetings, and teachers’ daily routines and classroom decisions, for a full school year. The objects of study in
this investigation were transcripts of interviews, transcripts of teachers’ meetings, journal entries, and records of the classroom enactment of 13 teachers in an elementary laboratory school affiliated with the university.

This study combines an ethnographic approach, in which the researcher immersed herself in the daily work of these Knowledge Building teachers to understand the decisions and behaviors of these teachers, recognized as sharing a common Knowledge Building culture (Collin and Bielaczyc, 2006). Additionally, three teachers volunteered to post bi-weekly reflections in an electronic journal, and to allow the researcher to record classroom enactments relevant to their reflections. Because these three teachers were included within the larger sample of 13 teachers, we were able to obtain multiple data sources, including documents, records, interviews, and observations, to achieve the analytical depth required of case studies and to build on the analysis of the ethnographic study of the teacher community as a whole.

3.3 Data collection methods.

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

3.3.1 Semi-structured interviews.

Face-to-face semi-structured interviews were conducted with individual teachers to identify their perspectives on Knowledge Building practice, including views on their own professional development (see Appendix A). These were open-ended, as recommended (Patton, 1990) to probe interesting perspectives and similarities and differences among teachers. Each interview lasted about 60 minutes and was videotaped and transcribed for analysis. All
interviews were conducted within one week, and no changes were made to the protocol during this time. These interviews were conducted with 13 teachers—the whole teacher community.

3.3.2 Observations.

Direct observation was used for the following events:

i. Teachers’ meetings: The researcher attended the teachers’ weekly Knowledge Building meetings, which lasted approximately 60-90 minutes and typically included all teachers in the school. The researcher tried to remain unobtrusive through analysis of video recordings of these meetings.

ii. Classroom enactments: Three teachers were selected as the focus of in-depth case studies in which the researcher observed a minimum of an hour of each teacher’s classroom interactions each week. This hour was either a knowledge-building discussion (a classroom conversation that the teachers and students referred to as KB Talk that focused on getting students to build on one another’s ideas) or a session where students worked on Knowledge Forum®\(^1\). These case studies involved teachers from limited to high levels of experience, one with five years of experience, another with three years of experience, and the other with one year of experience.

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\(^1\) Knowledge Forum® is the second generation of Computer-Supported Intentional Learning Environment (CSILE) (Scardamalia et al., 1989). It is an asynchronous discourse medium where students and teachers author or co-author notes that include multimedia elements, ideas, models, problems, plans, and data. Users can create graphic views as workspaces to hold these notes. Knowledge Forum also provides supportive features such as build-on, annotations,
3.3.3 **Written journal entries.**

For the three case studies, notes posted on Knowledge Forum® by the classes, and reflection notes posted by the teachers were analyzed to provide a complete and accurate description of the classroom activities.

3.4 **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 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; Collin & Bielaczyc, 2000; Zhang et al., 2009). The school currently enrolls about 200 students from nursery school (pre-K), kindergarten to Grade 6, with 22 students on average per class. Most families come from a middle-class background. As a laboratory school, Jackman ICS has been involved in initiating and disseminating new ideas related to improving education to other schools. Knowledge Building pedagogy and CSILE/Knowledge Forum were first introduced to teachers in Jackman ICS in 1994 and adopted across the entire school in the past decades.

As suggested above, the study was originally conceived of as an expert-novice study. However, there is an extensive literature on expertise, and this literature suggests that expertise should be defined in terms of 10 years or 10 000 hours of experience (Ericsson, 2006), as that is the estimated timespan needed to develop expertise in specific fields. Knowledge-building practice is a relatively new concept in schools, and teachers are for the most part engaged in
other activities, even in schools that incorporate Knowledge Building pedagogy. Thus it was not possible to locate expert Knowledge Building teachers based on standards presented in the literature on expertise. The available range of experience was 1 to 8 years—with the estimated maximum hours corresponding roughly to 4000. Further, there are no performance benchmarks by which we can independently verify whether years of experience translate into ability to achieve superior results. Accordingly, teachers were divided into three groups based on years of Knowledge Building experience: < 2 years; 2-5 years; and 5+ years.

The study was designed to explore differences related to years of Knowledge Building practice (not the same as number of teaching years) as the teaching profiles in Table 3.1 indicate

Table 3.1. Teaching profiles

<table>
<thead>
<tr>
<th>Knowledge Building experience</th>
<th>Number of years teaching</th>
<th>Knowledge Building practice (including use of Knowledge Forum®)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5+ Years Experience</td>
<td>More than 10 years</td>
<td>More than 5 years</td>
</tr>
<tr>
<td>2-5 Years Experience</td>
<td>More than 10 years</td>
<td>2 – 5 years</td>
</tr>
<tr>
<td></td>
<td>Less than 10 years</td>
<td>2 – 5 years</td>
</tr>
<tr>
<td>&lt;2 Years Experience</td>
<td>More than 10 years</td>
<td>Less than 2 years</td>
</tr>
<tr>
<td></td>
<td>Less than 10 years</td>
<td>Less than 2 years</td>
</tr>
</tbody>
</table>

Note: Knowledge Building experience is not the same as teaching experience

For reasons elaborated above, we used years of experience and followed guidelines for exploring behavior along a continuum rather than using a strict novice-expert division. This
continuum is reflected in the three case studies to be reported in Chapter 5, one from each of the three groupings by years of experience indicated in Table 3.1. Because of the substantial amount of work involved in these case studies, only 3 teachers were selected from the 13 teachers in the school for this level of analysis based on (i) the profile of the teachers, mainly fitting the variation in the number of years of active engagement in Knowledge Building pedagogy and (ii) the extent of teachers’ reflections and classroom observation notes available to explore the daily classroom progress in detail.

Scandura (1982) defines three stages in the development of expertise: (i) naïve, (ii) neophyte, and (iii) master. Dreyfus and Dreyfus (1986) developed a five-stage model that begins with the novice stage and moves to advanced beginner, competence, proficiency, and finally to expertise. Bereiter and Scardamalia (1983) elaborated this concept by questioning stereotypical notions of expertise and elucidating the difference between specialization and expertise. Following the previous literature, we examine two types of teachers’ experience: their teaching experience and their Knowledge Building expertise. For the purposes of this study, the Knowledge Building experience was considered more important than teaching experience, so the former was used as the main criterion in categorizing teachers.

3.5 Researcher’s Role

When “mutual shaping and interaction” takes place between the researcher and the participants (Lincoln and Guba, 1985:p155), the researcher becomes the “human instrument” in the research, building on her tacit knowledge and her propositional knowledge using methods of human inquiry—e.g., observations, interviews, documentary analysis and “unobtrusive” methods.
3.5.1 Data analysis and coding scheme.

The data were analyzed to address three research questions.

1. What kinds of problem spaces do Knowledge Building teachers construct and explore?

2. How do individual teachers, as reflected in individual case studies, construct and explore teaching problem spaces related to Knowledge Building practice?

3. How do these teachers, as a community, construct and explore teaching problem spaces related to Knowledge Building classroom practice?
Table 3.2. Operationalizing the research questions

<table>
<thead>
<tr>
<th>Research question</th>
<th>Data</th>
<th>Analysis methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What kinds of problem spaces do Knowledge Building teachers construct and explore?</td>
<td>One-on-one interviews with teachers to provide a description of their Knowledge Building practice, including the problems and challenges they encountered in their Knowledge Building practice</td>
<td>Qualitative analysis of teachers’ interview transcripts to code teachers’ problem space on Knowledge Building practice.</td>
</tr>
<tr>
<td>2. How do individual teachers, as reflected in individual case studies, construct and explore teaching problem spaces related to Knowledge Building practice?</td>
<td>Teachers’ reflections in journal entries; classroom observation notes; and teachers’ contributions in the weekly Knowledge Building meeting.</td>
<td>Qualitative analysis of teachers’ journal entries and classroom observation notes and contributions in weekly meeting to investigate three teachers’ (one year, three years, and five years of Knowledge Building experience) construction and exploration of problem spaces in their Knowledge Building practice.</td>
</tr>
</tbody>
</table>
3. How do these teachers, as a community, construct and explore teaching problem spaces related to Knowledge Building classroom practice?

| Teachers’ weekly meeting transcripts. | Qualitative analysis of the teachers’ weekly meeting transcripts to investigate the construction and exploration of problem spaces in the community, as reflected in important issues teachers identified. |

3.5.1.1 Data and coding scheme for interviews with teachers.

The video recordings of the individual interviews with teachers were transcribed. Text was segmented and coded. The coded transcripts for the 13 teachers’ interviews are contained in Appendix B1-B13. 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 (C/S); Social Interaction (SI); Student Capability (SC); Classroom Structures and Constraints (CS&C), and Technology (T). Each problem space is further analyzed mainly for the shift between centrist and relational perspective.

3.5.1.2 Data and coding scheme Teachers’ sequence of actions and decisions.

All data related to the actual classroom practice for teachers in the three case studies (meeting transcripts including discussion of events in their classrooms; their journal reflections; their classroom recordings; and their students’ notes on Knowledge Forum®) were organized in chronological order and analyzed to identify problem spaces and decisions.

3.5.1.3 Data and coding scheme for interviews teachers’ weekly meeting.
The video recordings of the teachers’ weekly meeting were transcribed. Both sets of Text was segmented and coded. The coded transcripts are contained in Appendix D1-D4. For the meeting transcripts, segments of meeting that shows interaction among the team were first identified to be either (i) a problem of understanding, (ii) a knowledge advance, or (iii) a technological issue (framed by the common agenda for all meetings). Segments identified as 'problem of understanding' were further analyzed mainly for the shift between centrist and relational perspective.

For (i), (ii) and (iii), The shift from centrist perspective and relational perspective is characterized by i) Surface to Deep features of problems (ii) Routine to Adaptive approaches (iii) Procedure-Based to Principle-Based reflection.
CHAPTER 4

Results Part (1)

4.1 Problem Spaces Constructed and Explored by Teachers with Different Levels of Knowledge Building Experience

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?” There were 11 questions in all (see Appendix 1).

Responses to interview questions were analyzed to address the first research question:

1. What kinds of problem spaces do Knowledge Building teachers construct and explore?

In Chapter 2 the following five core problem spaces were briefly introduced: Curriculum/Standards (C/S), Student Capability (SC), Social Interaction (SI), Classroom Structures and Constraints (C/S&C), and Technology (T). Below, excerpts from teacher interviews are used to provide an indication of centrist and relational perspectives for the five problem spaces. This chapter presents a general overview; more detailed analyses are presented in Chapters 5 and 6. Throughout, the five problem spaces are indicated in italics, with codes shown, to facilitate review.
4.2 Centrist and Relational Perspectives in Problem Spaces Identified in Interviews with Teachers

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 these problem spaces based on Knowledge Building principles (Table 2.2) and the more relational perspectives inherent in them.

4.2.1 Curriculum/standards (Code: C/S).

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 2-5 years 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.”
4.2.2 Student capability (Code: SC).

Teachers with <2 years 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)

4.2.3 Social interaction (Code: SI).

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…”

4.2.4 Classroom structures and constraints  (Code: CS&C).

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.”

4.2.5 Technology (Code: T).

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.”

4.3 Understanding Knowledge Building Theory and its Impact on the Construction and Elaboration of Problem Spaces

4.3.1. Teachers’ understanding of Knowledge Building Pedagogy.
Teacher’s understanding of Knowledge Building pedagogy, as well as their ability to implement it, grows over time. An early reaction is often “I do that already,” signifying that at a surface level the pedagogy has many characteristics shared by other constructivist pedagogies. As suggested below, distinguishing characteristics only become evident with Knowledge Building experience. For example, teachers with less than two years of Knowledge Building experience drew parallels to things they had previously learned, as suggested in the following example from a <2years teacher:

“I came from a US, inquiry-based learning program. The road towards KB, I began to understand the idea about 5 years ago, only through the constructivist approach, and I came to [Jackman] ICS and began to understand constructivist and KB. I thought the terms were interchangeable.”

For the 5+ years Knowledge Building teachers, although they also discussed and made reference to their earlier experiences, they would additionally discuss the value of the knowledge building process and how their understanding improved over years:

“I think as a teacher I have always been somebody who has been very flexible, I don't teach the same thing every year, I never try to think, ‘That worked very well, I am going to do the same thing again.’ I am always looking for ways to improve my practice, I think what the KB process brought to me was making that more explicit and embedding it in an environment that is so embraced and the work and the thing I do in class. I used to be…on my work… I was an individual looking at questions, and it really was more about just being the individual in my class. The way it is different now is that I am much more connected to the community that is thinking about the same questions, even though I am
in the same building, I am still more connected to the community thinking about the same questions, and it is so much more obvious that the questions that I am asking about the individual children in my class are broader questions that affect teaching generally. I think that is probably the change in my thinking, it has connected me in a broader way to other teachers.”

4.3.2. Teachers’ reflection on their practice: toward a model of continual improvement.

The following reflection on improving practice through risk taking and “casting about” is from a teacher with less than two years of Knowledge Building experience:

“I think there is a culture here where it is OK to take certain risks with your students, and those kind of things, taking risks or trying to do something different and innovative is valued and not seen, not looked down on, even if it is not really working out. I think most people here are forthcoming, they have all done things that have not worked out, they understand that there is a lot of casting [about] and see what will work and what won’t, there is value in the process, and everyone see it, and [it is] not an environment that you have to hide it if it didn’t go right.”

Teachers with more than five years of practice reflected on how they adopt and modify their experience from more of a relational perspective—taking into account the abilities of students and team members and the need to continually innovate and improve ways of teaching and learning:

“The sense of what it meant to do KB, I was still bringing it to the classroom, even when I was not using KF. It [was] hard to think of it before. Teaching is always
reflective, the design mode, the sense of always creating something; now what is interesting, I feel that I am helping to figure something out and developing something.”

“The third improvement would probably be, I think, to try, because [Jackman] ICS is such a different school, so much more innovative; I find that I am more open to new things then, so the whole atmosphere of the school is to learn more, you don’t become a teacher and stop there. So you keep learning; even though I am not young I still think I have a lot to learn. It teaches me a lot. The students teach me as much as I teach them.”

“I have adopted many of the innovations of my colleagues by adapting them to suit my classroom. For instance, I changed the scaffolds in last year’s KF view to reflect the abilities of my students after one of my colleagues suggested that he had done this for his class.”

4.4 Summary

Thirteen teachers were interviewed regarding their teaching practices and experience with Knowledge Building pedagogy. Their responses show that they construct and explore teaching problems along the same lines as skillful teachers engaged with other constructivist pedagogies. Accordingly, their interview responses could be readily aligned with the five core problem spaces common across many teaching models: Curriculum/Standards (C/S), Student Capability (SC), Social Interaction (SI), Classroom Structures and Constraints (C/S&C), and Technology (T). 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. From the literature review on teachers’ practice, it is clear that such shifts can only be revealed in analysis of fine granularity. The work in this chapter provides a starting point for the work elaborated in Chapters 5 and 6, where the analyses focus in much greater detail on holistic accounts of teachers’ practices as conveyed in case studies (Chapter 5) and in contributions as members of a Knowledge Building community (Chapter 6).
CHAPTER 5 Results (Part 2)

5.1 Case Studies of Three Teachers with Different Levels of Knowledge Building Teaching Experience

Chapter 5 addresses the second: How do individual teachers, as reflected in individual case studies, construct and explore teaching problem spaces related to Knowledge Building practice?

This chapter presents case studies of teachers with different levels of Knowledge Building teaching experience:  (a) Helen--one year of experience; (b) Nancy--three years of experience; and (c) Zahra--five years of experience. The case studies are based on complete records of teachers’ journal entries, researcher’s classroom observation notes, and teachers’ meeting contributions (condensed researcher notes reflecting teacher contributions to weekly teacher meetings). The full records are in Appendix B1-B3, coded to identify the five problem spaces constructed by teachers with different levels of experience. The problem spaces and corresponding codes are as follows: Curriculum/Standards (C/S), Student Capability (SC), Social Interaction (SI), Classroom Structures and Constraints (C/S&C), and Technology (T). These are indicated in italics throughout the discussion, as are the Knowledge Building principles presented in Table 5.1, to help convey teachers’ principle-based actions and reflections within different problem spaces.

Table 5.1 below shows examples of centrist and relational perspectives for the five problem spaces, with examples of codes for data analyzed in this thesis. Accordingly, this
overview provides easy reference to the coding scheme that is used to analyze interview data, journal entries, classroom observation, and teacher contributions.
Table 5.1: Examples of Centrist and Relational Perspectives and Codes for Five Problem Spaces

<table>
<thead>
<tr>
<th>Problem Space</th>
<th>Example of Centrist Perspective</th>
<th>Example of Relational Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum/Standards (Code: C/S)</td>
<td>I have been cutting down the ideas in the talk to just one, and it must connect to the original problem. (Code: C/S ~C)</td>
<td>I have to be able to tie those students’ ideas with the big ideas. (Code: C/S ~R)</td>
</tr>
<tr>
<td>Student Capability (Code: SC)</td>
<td>They have their skills and problems, but they also have trouble focusing and concentrating. (Code: SC~C)</td>
<td>They have amazing ideas, but how do they actually build on them? (Code: SC~R)</td>
</tr>
<tr>
<td>Social Interaction (Code: SI)</td>
<td>I really work hard to make sure that when we are having any kind of discussion about some kind of social conflict, we are not going to deal with deliberate unkindness . (Code: SI~C)</td>
<td>I asked them to tell me what they thought of the view. (Code: SI~R)</td>
</tr>
<tr>
<td>Classroom Structures and Constraints (Code: C/S&amp;C ~C)</td>
<td>One challenge is always time. (Code: C/S&amp;C ~C)</td>
<td>I shift the schedule around to have half-group talk. (Code: C/S&amp;C ~R)</td>
</tr>
</tbody>
</table>
The case studies reported in Chapter 5 begin with the work of the teacher with the least experience in Knowledge Building pedagogy, and end with the teacher with the most experience. The least experienced teacher taught Grade 1; the teacher with mid-level experience taught Grade 2; and the most experienced teacher taught Grade 3. It is accordingly impossible to disentangle teacher experience and student maturity. However, the most experienced (Grade 3) teacher in this study subsequently moved to Grade 1, using many of the same strategies and processes. Her students outperformed older students, suggesting that her experience is an important factor in enabling her students to exceed grade-based expectations. Further, the ability to take into account more variables—as required by the relational perspective associated with experience—is replicated in other studies. This shows there is independent support for relation perspective on problem space. What sets this work apart is the detailed account provided of the shifts from surface to deep, routine to adaptive, and procedure-based to principle-based that enable teachers to work within a more complex, relational perspective.

To anticipate results, teachers move between the five problem spaces continually, with the pattern dependent on context. But there is, nonetheless, a general pattern that characterizes the work of each of the three teachers. Early in the year each teacher’s work within the
Curriculum/Standards (C/S) problem space reflects the core challenge of engaging students in Knowledge Building: to create an idea-centred classroom in which students’ ideas represent a driving force for knowledge advancement. The shifts in practice required to accomplish this move from centrist to relational perspectives are shifts previously characterized as (a) Surface to Deep: from focus on obvious or evident features to ill-defined problems, big ideas, and promising possibilities; (b) Routine to Adaptive: from routines to adaptive flexibility and novel approaches; and (c) Procedure-Based to Principle-Based: from procedure-based actions to principle-based reflection-in-action.

The teachers all begin by encouraging students to express their ideas. Follow-up efforts are then aimed at bringing students’ ideas into alignment with various curricular goals or expectations for knowledge advancement, and addressing student ideas that are judged to be non-productive. The teacher with the least experience focused on identifying a specific activity to bring about Knowledge Building, an activity that would limit the production and spread of ideas considered non-productive. Her solutions tended to reflect a centrist perspective--keeping ideas in check rather than finding solutions within a principled, Improvable Ideas framework. Accordingly, her work in the Classroom Structures and Constraints (C/S&C) problem space was aimed at finding a structure to constrain the spread of ideas rather than discover student interests underlying those ideas. The teacher with mid-level experience spends more time addressing the actual ideas the students bring to the discourse. She began with a idea of what she wanted the class to do, and tried to align that plan with emerging student ideas. The relational perspective is most clearly exemplified in the teacher with the most experience, who starts by drawing out students’ ideas relevant to the content area to be explored. She allows curriculum goals to be sidelined as she works to ensure that all students have expressed an idea worthy of extended
inquiry. She is clear that student ideas represent an important basis for engagement and knowledge advances. Thus, rather than generating a set of activities, she works with students to encourage idea productivity, and then engages in improvisation within the ill-defined problem space bounded by curricular goals and students’ ideas.

The effort to engage students’ ideas leads each teacher to work in the Social Interaction (SI) problem space to establish what they refer to as the class "problem of understanding"--the collective challenge that the class will tackle. Each teacher must manage disruptions of one sort or another while working in this space, a challenge to be expected with any process that requires the transformation of individual contributions into a collective enterprise with a shared goal. This effort to define a shared goal reflects a relational challenge in its own right—the challenge underlying the Knowledge Building principle of Community Knowledge, Collective Responsibility. Another common challenge to be elaborated in the case studies below is managing the technology so students’ ideas are presented in public spaces where peers can contribute, build on, reference, and in other ways work in, the communal knowledge space Knowledge Forum supports. The core challenge created by this aspect of a Knowledge Building community is that of managing all the entries on Knowledge Forum views. Managing views with many and diverse ideas, while advancing understanding in light of curricular expectations, represents another relational challenge. The solutions the teachers attempt vary with their experience, as do their efforts to address students’ interactions and capabilities. As elaborated below, shifts from centrist to relational perspectives correspond to increasing levels of work in ill-defined problem spaces, searching for the big ideas and promising possibilities rather than constraining idea generation. They require adaptive flexibility, novel approaches, and principle-based reflection-in-action across a broad range of educational activities.
5.2  Case Study #1: Helen (Least Experienced Knowledge Building Teacher--One Year of Experience)

5.2.1  Teaching experience and context for current research.

Helen graduated with a two-year MA degree in Child Study and Education, spending two years in an internship at Jackman ICS. She was introduced to Knowledge Building theories during her MA program. She had one year of teaching experience in a public school before she began teaching at Jackman ICS, and this research study began during her first year as a Knowledge Building teacher. She taught Grade 1, and in that year Helen planned to cover the following Science and Technology curriculum (The Ontario Science and Technology Curriculum, Grades 1-8):

<table>
<thead>
<tr>
<th>Strand</th>
<th>Topic</th>
<th>Inquiry in class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life Systems</td>
<td>(i) Characteristics and Needs of Living Things</td>
<td>Life cycle of a butterfly</td>
</tr>
<tr>
<td></td>
<td>(Grade 1)</td>
<td>(Grade 1)</td>
</tr>
<tr>
<td></td>
<td>(ii) Growth and Changes in Animals</td>
<td>(Grade 2)</td>
</tr>
<tr>
<td>Structures and Mechanisms</td>
<td>(i) Everyday Structure</td>
<td>Structures around us</td>
</tr>
</tbody>
</table>

5.2.2  Excerpts from journal entries, classroom observation notes and meeting contributions.

Helen started the year by asking:
Helen’s journal entry  "I need to understand what is my role in the KB Talk at this stage"

on 15th October  C/S~C

She continued to explore and refine the structure and format of KB Talk needed for a successful discussion (segment H-J-10/15). She seemed aware of the principle of Community Knowledge, Collective Responsibility, which she expressed as follows: “I should be involved as little as possible, to allow the children to feel that their voices and ideas are as important as my own.” However, she described her decisions as “instinctive” “first reaction,” or “gut reaction” on several occasions, suggesting implicit understanding of principles rather than explicit principle-based reflection-in-action. And as elaborated below, there was frequently greater focus on surface features of the problems than deeper analysis that might lead to novel approaches.

At the teachers’ weekly meeting in September (segment H-M-09/12) Helen described how she had attached a camera to the butterfly cage to capture on tape the metamorphosis of the chrysalises into butterflies. When students saw that morphing process, they began to ask questions about the process, along with many other questions that were both related and unrelated to the metamorphosis process. These questions were captured in a KB Talk (in segment H-C-10/11-01), but not entered into the communal space in Knowledge Forum.

Helen continued to explore the format of the KB Talk. She wanted a procedure “so that all students feel successful and get a sense of themselves as someone who can participate in these

2 Explanation of notation H-J-10/15-L1: H denotes the teacher, Helen; J the data source, journal entry; 10/15 the date of the event, month/day; and L1 the line number within that segment. The two teachers in other notations are represented as N (Nancy) and Z (Zahra); other data sources in other notations are C (classroom observations) and M (meeting contributions).
talks.” The procedure she settled on was designed to help students connect ideas. She got students to use duplo-blocks (H-M-10/13-L03), with each plastic block building on another to represent building of ideas. The format was to ensure that everyone had an equal chance to contribute. While there was no explicit reference to the Knowledge Building Principle Democratization of Knowledge, it seemed this was the teacher’s intention.

This intervention received praise and recognition from other teachers in the community. However, Helen only used the duplo-blocks twice, and midway through one talk she decided to do away with the duplo-blocks (observed in her class later in October: segment H-C-10/18), as she felt that there were many disjointed ideas when students were using the blocks. This represents an important shift—a shift from focus on procedures to an additional constraint on the design—in the building of ideas and search for more promising possibilities. Her need to get students to focus on ideas is seemingly a reference to the Knowledge Building principle Improvable Ideas.

As Helen progressed in her first year of Knowledge Building, she had informal discussions with her peers, trying to figure out a “truly productive KB Talk” for her students. While she did not refer to principles directly, nor to the ideas she hoped would grow, she shifted from focused work with procedures and surface features in the Classroom Structures and Constraints (C/S&C) problem space to more principled approaches. For example, she stated that she wanted students to “feel that they are building knowledge without my direction” (in segment H-J-10/19-02)—another implicit reference to the principle of Epistemic Agency. However her hold on principled reflection-in-action was tenuous, as she returned to efforts to fine-tune activity structures and procedures to improve the discussion, and focused again exclusively on the activity rather than on Improvable Ideas. For example, she considered the use
of non-structured snack time as time for talks (in segment H-J-10/19). Throughout, she showed a willingness to take risks with format and structure, indicating, “I am continually surprised when I take risks, like letting students try a KB Talk without hand-raising and without intervening.” At the next KB Talk, she entered a Social Interaction (SI) problem space that demonstrated adaptive flexibility and a promising new possibility, both from a relational perspective. She engaged her students in working on the format of the KB Talk. She did not, as a more experienced teacher might, consult with them on forms of interaction that might advance their understanding, but she did poll students on the format they preferred for their talk. Below is a short excerpt from her KB Talk early in the latter part of October (H-C-10/18-L60-L66).

Helen: Boys and girls, here’s I want to do, just for about 10 or 15 minutes. I want to try something it a little differently now, OK? We are going to try something different. If you look around, some ideas are really getting build-on, some just one block. They are really interesting ideas. I am wondering if we have so many ideas that we are not able to get them all.

OK, we are going to try again (count down). OK, for a very short time, I want us to try talking in a different way. We are going to try without blocks, and we are going to try without hands-up – I don’t know, Grade 4s do that, and what can we do to be still respectful?

Student A: Don’t talk over other people’s voices.

Student B: People don’t know who to pick.

Student C: Let’s vote – two choices – try hands up or not.
Student D: Maybe we should vote.

Helen: Put your hand up now if you think we should have our hands up more. Close your eyes. Put your hand up if you don’t want to have your hands up. Now put your hand up if you want to have your hands up. More people pick don’t want to put hands up!

In her journal entry (H-J-11/04) Helen reflected on the characteristics of a KB Talk and the richness of knowledge building in class and in Knowledge Forum. With this, she moved from focus on the problem space of Student Capability (SC) and behavior to students’ discourse. She considered students’ difficulty in trying to respond to more than one person when in a group, compared to work on Knowledge Forum and in smaller groups. She also started to see Knowledge Building Discourse as a principled approach to Social Interaction (SI) rather than as a specific format.

Helen in her journal entry in early November (Segment H-J-11/04) “... because I have rich conversation with individuals and in small groups that I was not considering as part of the KB Talk...”

But weeks later she again returned to the Classroom Structures and Constraints (C/S&C) problem space and to the idea that the structure and format of the talk would determine its effectiveness. There was no sense of working within a relational network of principles—no consideration of Idea Diversity, Improvable Ideas, and Community Knowledge, Collective Responsibility—at this point.
Helen in her journal entry in late November: “I have tried to get time out of my structure for half-group KB Talk, to see if that might work better.”

Helen visited the classroom of another teacher in her school. After visiting Nancy’s class (see Helen’s journal entry in November, segment H-J-11/04), Helen reflected on how that experience helped her understand her own struggles in establishing effective procedures for KB Talks. She identified as a characteristic of knowledge building that students should be “able to collectively follow an idea through from a question to some theories”; she then considered the kind of “conversational format” possible in her class, which led her to think about changing certain formats, such as “if we make the groups small enough.” In November she indicated that there could be connected conversation in a large group, but just not for everyone at every moment. She began to construct quite a different set of problems after realizing that a good KB Talk might not have all children engaged at all times. She then began to focus on procedures that would allow greater focus on the content of the conversation:

Helen in her journal entry in late November (Segment H-J-11/04): “And I saw that although there were children who were not always engaged, those children were still able to participate at different points throughout the conversation and contribute wonderful ideas.”

At this point, her problem space began to shift closer to the idea-centred approach: i.e., her statement, “I feel like there is a piece that I can include to allow every child to connect with
the information, and not just connecting to each other,” and her realization that “this moving in and out of attention was not a failing of the talk, but a reality of such a little body and mind engaging in this complex exchange of ideas.”

Helen in her journal entry in late November (Segment H-J-11/04) wrote: “I knew, watching the Grade 2s, that this moving in and out of attention was not a failing of the talk, but a reality of such a little body and mind engaging in this complex exchange of ideas.”

This signals a more relational approach to the Social Interaction (SI) problem space, with advances beyond routines signaled in her concerns about students who were not able to connect meaningfully and their efforts to deal with complex ideas. She felt that there were things she could do to get all students to connect, albeit at different levels and degrees of connection.

Her next approach seemed a clear surface to deep shift aimed at getting students more directly engaged with big ideas. She reframed the Curriculum/Standards (C/S) problem space to make “summarizing the big idea” a standard activity after every KB Talk. She also described how she might want to get students to draw their idea after every KB Talk so that she could “assess each child’s thinking.” This led to work in the Student Capability (SC) problem space, including consideration of students who need special attention.

Helen used the analytic tools built into Knowledge Forum interestingly — seemingly more to obtain information regarding contribution rates than as a shift to principled work surrounding Concurrent, Embedded and Transformative Assessment. She used the tools to reflect on which student she needed to pay more attention to, but this happened only twice; she mainly
relied on her observation in class to determine the next move in her class. These analyses of students’ interactions in class also prompted her to explore the quality of students’ notes.

In order to ensure that there was improvement in the quality of the notes, she decided to limit the content of the talk to one idea, so that the conversation was more connected. She never clarified how this was to operate in light of the Knowledge Building principles of Idea Diversity and Rise Above, as opposed to simplifying Knowledge Building Discourse by constraining the possibilities. Thus, this step seemed to reflect more procedure-based than principle-based work.

Helen worked within the Social Interactions (SI) problem space in KB Talk to address the distress she felt when her students veered off to discussions of “bad people.” We see her reflections in the following journal entries
In her journal entry on 25 November (segment H-J-11/25) "The first was a point raised by one child who said that families protect us from bad people, several children perked up at this and a short discussion followed, where students pondered why someone would want to take you from your family (one answer that many seemed to find satisfying was that robbers would steal you and train you to be a robber) I redirected and thought the talk moved onto a less potentially upsetting area. At another point, a child discussed whether you might be eaten by something when traveling in the jungle if you left your family."
Overall though, I thought there were other interesting ideas raised and I wasn't concerned. However, when asked to draw something from the talk, over half of the pictures featured robbers and "bad people" trying to take children away. Some of this can be explained away by a group phenomenon - it only happened at a few tables and seemed to be initiated by a few key children, with others copying from the pictures/discussion that ensued.”

Helen did not conduct a KB Talk for the next several weeks, nor did she probe further. However, she subsequently observed that her students were applying a convention from their KB Talks (e.g. choosing the next person to speak after they had spoken), and that that had a positive impact. Based on this feature, she generated a Social Interaction (SI) problem space. She asked students to create a visual representation of their ideas before sharing them with friends, and she had small groups work independently. She tried to support students in developing their ideas before influencing peers. In effect, she used Classroom Structures and Constraints (C/S&C) -- working at a “feature” or “activity” level—but with greater attention to Improvable Ideas. Interestingly, she noticed that students continued to use the KB Talk format in class even when
she did not specifically structure the situation as a KB Talk. Her students spontaneously applied what they referred to as KB Talk conventions to their face-to-face interactions.

Helen then returned to “format,” reflecting on a discussion in an earlier teachers’ meeting concerning KB Talks becoming too formalized and not as effective as they should be. She reflected on the need for “moving students to a deeper understanding,” but there was no evidence of principle-based initiatives. She felt the core problem resided in the Student Capability (SC) problem space. If she allowed children to lead the conversation, then some children might not be able to follow. The form the KB Talk might take was seen as constrained by the number of students in the class. Thus while the evident problem—students might not advance the conversation in a way that was helpful for all students--limited the solutions considered, it is noteworthy that she was working at the intersection of the Student Capability (SC) and Social Interaction (SI) problem spaces, grappling with the Knowledge Building principle implicitly, Democratization Of Knowledge, which led her to identify a format for a KB Talk that was different from that discussed at the meeting.

The evident problem was to get as many students to contribute as possible. Helen appreciated that her rather superficial “procedural” approach led her to be too focused on the “number of contributions.” She was clear that her goal was to increase “real conversational flow” in her class, but she stayed with the more evident and procedural aspects of the problem space, with no reference to the actual ideas being generated and how they might connect or advance the discussion. She modified student groups to create smaller groups, and noted that students seemed more forthcoming with their ideas—“suddenly this tiny group was talking seriously about structure ... .”
Helen watched the video of her class when they were in the previous grade at the weekly teachers’ meeting. She was relieved to learn that what she experienced as “chaos” in her class during the KB Talk was evident in other contexts. She defined the success of a KB Talk in terms of how well students’ ideas were connected, and she imagined an ideal KB Talk. She continually constructed her problem space around management of students’ behavior, without considering the nature of students’ ideas and how they could be advanced. Thus she remained focused on procedures; there was some suggestions of implicit efforts to introduce additional principles for knowledge building principle, but for the most part she was mired in the consideration of procedures and routines.

Helen identified the following indicators of a successful KB Talk: (i) “types of questions”; e.g., “question was big in different ways”; (ii) “one idea getting bigger and bigger”; (iii) “turn-taking.” For (i) “types of questions,” she identified the few notes on Knowledge Forum that were “related to structures”; she did not really consider the core issues underlying these notes. She did, however, indicate that the open-ended question worked well, and she felt that she could replicate this kind of question in future KB Talks. For (ii) “one idea getting bigger and bigger,” Helen made a special effort to ensure that students remained focused, and that they built on one idea, rather than encouraging different ideas to surface during the KB Talk. Her use of duplo-blocks was explicitly guided by efforts to support an idea-centred approach. She remarked, “I could actually see the idea moving from person to person, changing a little, being added to, and I could feel the concentration that they were all giving to the idea.” For (iii) “turn-taking,” Helen was pleased that the students were able to use the format of KB Talk and accept one another’s ideas.

In her journal entry in May the following year, Helen reflected:
“I don't know if it was practice, familiarity with the format, or if some of the comments made throughout the year were accepted more deeply but there wasn't outrage when someone jumped in to argue a point or to rephrase when they were misunderstood, and when that train of thought ran out, they seemed to be able to go back to hands-up and choosing the next person without a lot of transition time. “(H-J-05/02)

At the end of the year Helen posed an important question: “What if this focus on ideas means that children’s voices are not heard in the classroom equally?” (H-J-05/02). It seems that, rather than engaging in problem solving within a complex, interacting system of affordances, she was engaged in principle-based reflection; but the principles were being considered in isolation—at one point Democratizing Knowledge, at another Improvable Ideas, rather than finding procedures that allowed her to tackle both challenges in parallel. Also, she did not, as we will see more experienced Knowledge Building teachers do, engage students in problem-solving regarding supports, tools, or strategies that might allow them to sustain a flow of ideas and deal with disruptions. Nor did she reflect on ideas underlying students’ introduction of ideas that she felt interfered with Knowledge Building, thus possibly missing an opportunity to define the Social Interaction (SI) problem space from a more relational perspective. Instead she explained success and failure on the basis of various formats and structures implemented during the talk.

5.2.3 Summary: case study #1 of Helen (least experienced knowledge building teacher--one year of experience).

In summary, the analysis revealed that although Helen continually adapted her work to address curricular goals and student needs, and considered emerging knowledge-building
patterns in her class, she focused primarily on procedures and protocols in the *Social Interaction* (SI) problem space. Her concern was largely with establishing effective classroom interactions in face-to-face contexts; there was limited attention to the *Technology* (T) problem space. She focused on students’ behavior more than on the substance of their ideas; she demonstrated an implicit understanding of a number of Knowledge Building principles but neither an explicit awareness of them nor an integrated approach to them, as suggested by the fact that she focused on one principle or procedure at a time. Accordingly, procedures meant to address one problem served to raise new challenges. For example, to engage students more equally, she had them work in small groups, which then limited *Idea Diversity* and *Community Knowledge, Collective Responsibility*. But she recognized the need to advance on more fronts, and her procedures did not limit that potential, but rather represented steps in a series of risk-taking efforts to advance students’ ideas.

5.3  **Case Study #2: Nancy (Mid-Level Experience Knowledge Building Teacher--Three Years of Experience)**

5.3.1  **Teaching experience and context for current research.**

Like Helen, Nancy graduated with a MA degree in Child Study and Education through an on-site study at Jackman ICS. She was exposed to Knowledge Building during her two-year program and in the first three years of teaching as a qualified teacher at Jackman ICS. However, because she was working with nursery-school children in her first two years of teaching, she did not bring Knowledge Forum into her class. As a result, she had three years of Knowledge Building teaching experience at the time this research study began, with her teaching in a Grade
2 classroom. In the year of the research study, Nancy planned to cover the following Science and Technology curriculum (The Ontario Science and Technology Curriculum, Grades 1-8):

<table>
<thead>
<tr>
<th>Strands</th>
<th>Topic</th>
<th>Inquiry in class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matter and Material</td>
<td>Properties of Liquid and Solid (Grade 2)</td>
<td>Water cycle</td>
</tr>
<tr>
<td>Earth and Space Systems</td>
<td>Air and Water in the Environment (Grade 2)</td>
<td></td>
</tr>
</tbody>
</table>

5.3.2 Excerpts from journal entries, classroom observation notes and meeting contributions.

Nancy began exploring the Curriculum/Standards (C/S) problem space by setting an explicit curriculum goal that she wanted to achieve over the course of the year, and by designing specific activities to get students to think and ask questions about water. Though she was prepared to embrace students’ questions on water, she had planned particular questions that she wanted to introduce in her class. She stated: “I was toying with questions of an island and what would we bring [to an island],” and she felt these questions would be good for their study of water. She did not frame the class inquiry with her questions, but encouraged students to pose questions, and noted great Idea Diversity in their questions.
Nancy, in a weekly meeting in the September (segment N-M-14/09) "I am still thinking what could be the doorway to sustainability for seven-year-olds? I have already asked the kids to bring water from their travels or their home. I wasn’t going to launch right into water, I was toying with questions of an island and “what would we bring?”…”

“but kids brought water and questions about water, and there’s no holding them back. Why is water shiny? Why does sweat makes you cold? What is temperature? I also have kids bringing in leaves and a lot came up about the trees.”

After the students shared their water questions and samples, Nancy reflected on the flow of the activity. She felt that it was taking too much time for each student to come forward to share their “water story”; she felt it would be better if the sharing were done in parts.

Nancy indicated that she uses students’ ideas to decide what to do next, including making sure that students have a chance to go to the library to advance work on their questions and review related literature, as well as conduct experiments and engage in discussions. As her journal entry late September suggests (segment N-J-09/14), students’ questions informed her work.
Nancy’s journal entry in late September (N-J-09/24) “It was a question Student A had posed. Who made up all the words we say? I was not completely sure about going more deeply with it because it did not match my goals of “sustainability” and “water” as our area of inquiry, however, when student M told us he had discussed student A question with his uncle, I felt it was worth following up on. I thought at least it would be a good practice of how to have a KB Talk.”

Nancy demonstrated her ability to move beyond prescribed lessons and routines in adapting to students’ emerging ideas—which requires both adaptive flexibility and improvisation, as it was not clear how students’ questions would connect to the inquiry. She reviewed questions and “problems of understanding”—a phrase related to the scaffold support “I need to understand” in Knowledge Forum. This scaffold was designed to support students in identifying what they need to understand to move forward with whatever work they are engaged in.

Nancy’s goal was to advance her inquiry on sustainability, which she set as the main inquiry theme for her class. She noted that her students brought in many questions on water, and she did not restrict questions or problems of understanding. Thus she fostered work in line with the principle of working with Idea Diversity, and this created the need to work back and forth
between curriculum goals and students’ ideas. She was actually the only teacher who recorded an episode surrounding a misconception—a student’s “cloud bag” theory regarding what produces rain. The excerpts below were traced through the various problem spaces she generated after the emergence of this misconception, which is discussed further below.

As suggested above, and in line with an idea-centred classroom, Nancy ensured that students’ questions were included as much as possible while maintaining an *Improvable Ideas* agenda. She noted that it is important to “honor students’ great questions,” which were generated as the class engaged in KB Talks and wrote notes on Knowledge Forum.

She guided the students in making sense of all of the questions, and referred them to the following main questions, written on the board in class:

**Questions in major categories**

**Water and survival – why do we need water?**

**About water: Why does a river move? Why is water wet?**

**Why does it rain?**

**Who made the first language?**

Nancy went through the class database and picked up three ideas that she felt would help in advancing the class inquiry on water. In her journal entry in November (segment N-J-11/22), she wrote:

*Interesting conversations in the database that would be worth following up on,*
1) clouds burst/ don’t burst – this could be a great topic for us to do more research on.

2) NHL hockey ice – I would love to find out more about this because I think the kids would be interested in it.

3) “why is water wet?”- this is not a big topic, but I’d like to share the etymology of the word if I could find out something about it.

Even though she had these ideas that she wanted to explore, Nancy did not use them to start off the KB Talk. She was guided by the principle of Real Ideas and Authentic Problems. She tried to create the conditions to help students connect their talk to their ideas on Knowledge Forum, by projecting the Knowledge Forum view on the screen in class and asking students if they had any interesting notes on Knowledge Forum that they would like to discuss. This represents a shift toward a more relational Curriculum/Standards (C/S) problem space—a problem space expanded by her contributions to that space, as suggested above. This is aligned to the Knowledge Building Discourse principle, in which everyone has a responsibility to contribute to the discussion.

As the following efforts convey, Nancy spent a great deal of time and effort trying to understand the root of the “cloud bag” misconception, and to engage students in exploring ideas, rather than directly correcting the misconception. In constructing the Social Interaction (SI) problem space, she provided opportunities for the students to talk about two conflicting ideas that had been raised about the formation of rain. She also took time to talk to the student with the “cloud bag” idea, to try to identify the root of this misconception.
Nancy in her journal entry in January (segment N-J-01/28) 

“Thought a lot about Kenny’s statements and theories – how they might be of benefit to all our thinking – how I had maybe got caught up by his “cloud bag theories” and missed some of his bigger questions that could help us (“how can water be in the sky without a container?”) – how we might protect him from staying in a polarized position.”

After a few explorations of the misconception that rain results from the formation of a “cloud bag,” and explorations of related concepts, which spanned three months, Nancy felt that the students had advanced as far as they could. She reflected on her role, and felt that it might not be fair for her to exert her authority and directly correct the misconception after students had worked so hard to discuss their two views on how rain is formed, yet she felt she could not let the misconception spread within the class. There was no evidence that Nancy searched for the deep, underlying big ideas in the domain, which could perhaps have allowed her to engage students in discussions of their disparate ideas and use the *Rise Above* principle to achieve explanatory coherence; perhaps she had exhausted the possibilities within her own understanding of weather and rain and was unable to find a connection between the “cloud bag” theory and a scientific account. In any event, she corrected the “cloud bag” idea, and this discussion ended shortly after that.
Nancy was always ready to use students’ questions to guide her lessons, and to explore students’ intentions in bringing up a question. For example, she noted, “Gerry was eager to talk about what water is made of, mostly because he had an ‘answer’.” She further reasoned that “even if Gerry had an answer, there was more [that] he, and we, might want to think ... .” She continually sought a deeper understanding of “working with students’ ideas.”

Nancy, like Helen, designed specific activities to reach her goals. For example, she designed activities to test four different water samples: (1) class water; (2) distilled water; (3) puddle water; (4) ICS tap water. Samples were tested for temperature, pH level, dissolved oxygen, and turbidity. Activities included a rain-in-a-jar experiment, or reading books on specific topics, or library sessions to help students make sense of their questions and ideas. Her activities introduced needed information or helped to shape students’ ideas and questions in ongoing inquiry, rather than establishing constraints on Improvable Ideas. This represents a more relational approach to Curriculum/Standards (C/S) than Helen’s work in the Classroom Structures and Constraints (CS&C) problem space. As indicated above, Helen tried to foster idea improvement by eliminating ideas that might thwart advances. As we will see below, the more experienced teacher starts by opening the space of students’ ideas from the very beginning of her work in the Curriculum/Standards (C/S) problem space.

Nancy continually monitored students’ conversation outside her regular KB Talk, during snack time, lunch time (with small groups of students), and field trips, with focus on ongoing Knowledge Building Discourse. She also set aside special KB Talk time to discuss rules of engagement in knowledge building, hoping to bring students to a deeper understanding of their knowledge-building efforts in class, working in the Student Capability (SC) problem space. In one of her classroom observations in late January (N-C-01/26), she said:
Before we discuss our research, I have a question. When scientists work, do they have one idea that stays the same, or do they sometimes change their ideas? When we think about knowledge building in our class, we are acting just like scientists. Our ideas are always changing as we learn more information. So, some of us have new research to share.

We see in this an attempt on Nancy’s part to engage her students in understanding the processes underlying Knowledge Building.

5.3.3 Summary: case study #2 of Nancy, (mid-level experience Knowledge Building teacher—three years of experience)

At one of the final teachers’ meetings of the year, Nancy shared the following insight on Knowledge Building practice:

Nancy in a weekly meeting in Oct (segment N-M-10/26) “I think it is my goal that every child gains an understanding, and within that there are different levels of ability ... I do have a goal that every child would learn ... that is the goal within the emergent part, the emerging part is I don’t know what day would be on ice, condensation on another, and...we do different experiments.”
This excerpt indicates how Nancy works with students’ ideas, integrating them into her predetermined curriculum plans and activities, including book reading, experiments, and themes. While there is a general framework into which everything fits, the details emerge as the work proceeds. We also see in her work an approach to dealing with a child’s misconception—an approach that required considerable work in a Curriculum/Standards (CS) problem space, dealing with relationships between the curriculum, scientific ideas, and students’ ideas. While she was engaged at the relational end of the centrist-relational continuum, we have no evidence of an effort to get to the big ideas in the domain that might have allowed her to engage students in explorations such as how the bag works—what lets water in and out? What’s happening with clouds when it is not raining? While she provided time for students to explore ideas available, the records do not convey a clear account of the nature of those ideas. As a result, there is no way to determine if plans, activities, and themes prevented potential breakthroughs.

5.4 Case Study #3: Zahra (Most Experienced Knowledge Building Teacher—Five Years of Experience)

5.4.1 Teaching experience and context for current research.

Zahra is the most experienced teacher, having taught for 22 years at the time this research started. It was her fifth year in Jackman ICS, and her fifth year as a Knowledge Building teacher. Zahra is unique in that she started doing educational research in 1990, so that by the time she came to Jackman ICS, she already had 10 years of educational research experience. The year of the study was her fifth year as a Knowledge Building teacher in a Grade 3 classroom. In that year, Zahra covered the following Science and Technology curriculum (The Ontario Science and Technology Curriculum, Grades 1-8):
5.4.2 Excerpts from journal entries, classroom observation notes and meeting contributions.

Zahra did not identify an explicit curriculum goal at the start of the year, but constructed the Curriculum/Standards (C/S) problem space on the idea-centred premise that students’ ideas should have priority over her construction of a fixed curriculum plan. This approach was reflected in her statement in the first teachers’ weekly meeting of the year, segment Z-M-09/14-01: “I am waiting to see what may emerge from the kids.” Zahra was also the only teacher who set clear goals to improve knowledge-building practice in a principled way, through use of data from the analytic toolkits on Knowledge Forum. She added: “[I am] really interested in using the Analytic Toolkit at the end of each day to inform my daily teaching. How the tools link to the [KB] principles. How they help the kids to understand the principles better.”

Zahra’s comments and subsequent classroom activities are consistent with the Knowledge Building principles. For examples, she collected students’ emerging ideas on the topic of the day/night cycle in a series of “morning message times,” aligned to the Idea Diversity principle. She engaged the students in working toward common understandings and goals, engaging them in activities designed to create data to help them generate and advance their ideas. For example, she had her students note the daily time of sunrise and sunset, and talked about the trend of these recordings. She recorded these data on the side of the board. That
continued for two weeks, during which time she and her intern recorded students’ emerging questions and ideas.

At the next classroom observation in mid-September (Z-C-9/15/06-01), Zahra had her students contribute notes on Knowledge Forum. She took time to explain the rationale in terms of knowledge-building contribution, and at the same time, allowed her students to suggest other topics at every Knowledge Building Talk:

<table>
<thead>
<tr>
<th>In subsequent classroom observation in October (Segment Z-C-10/02)</th>
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</thead>
<tbody>
<tr>
<td>“We thought it [was] an interesting thing to start with, but we also thought you have other problems of understanding, some other things that are about cycles. So when you get on the database, we created a view for you to work on; you can put questions not only about the cycle of the moon but about other cycles.”</td>
</tr>
</tbody>
</table>

On 2nd Oct, Zahra indicated the fit that she and her intern saw between students’ ideas and an important curriculum goal—indicating the adaptive approach to the *Curriculum/Standards (C/S)* problem space she set the stage for early in September.
Zahra, in her journal entry in October (Segment Z-J-10/02) “The reason Marianne [intern] and I thought that cycle is a good topic to start with is because many of us seemed to be interested to know why the moon is rising and setting at a different time every day ...”

Later, she reflects on how well her students took to knowledge-building—a principle-based reflection, in Zhang et al.’s (2009) terms, as the teacher was reviewing the classroom processes in light of knowledge-building efforts.

“I was really pleased . . . with the notes the children made. They really understand what to do and most needed no help in writing their notes.”

Zahra reflected on the process in her class:

“I asked the children to see if they could see the full moon this weekend and they told me they did as they came this morning. As part of the calendar talk, many children had told stories of seeing the moon rise and seeing a yellow moon. It was really neat to see how enthusiastic they are.”

She explained her reason for a KB Talk based on students’ enthusiastic responses:

“I felt it was important for the children to have a chance to talk about what was going on the view.” Zahra continued to adapt her classroom design based on students’ problems of understanding, and set homework for the students based on her efforts to work with students’ problems of understanding, as indicated below:
She reflects on her decisions and KB Talks based on students’ enthusiastic response: “I felt it was important for the children to have a chance to talk about what was going on the view” (shared in weekly meeting in September, Z-J-10/12).

In an October weekly meeting (segment Z-M-10/27) “I went through the database and identify problems of understanding that they are curious about right now, and then the child who wrote the note, we wrote it on these cards so we can hand them up and have them off the database and see what we are up to. And then next week for their homework, on their sheet, they are going to write the problem of understanding that is most pressing to them now.”
Zahra is concerned about disruption in idea improvement stemming from poorly developed ideas in notes (what she refers to as “silly notes”). Her efforts on this front convey work in both the Technology (T) and Social Interaction (SI) problem space, and reflect challenges due to her idea-centred approach and use of Knowledge Forum to help advance the principle of Community Knowledge, Collective Responsibility.

While the “silly notes” on Knowledge Forum were of concern, she also noted that there were “some good ones [notes],” and she attempted to understand them.

As indicated in this note, Zahra attends to both surface features of notes (“annotations,” “string of notes”) and to their more promising possibilities—“what the moon is really made of.” She planned a specific action to counter the “silly notes” problem; she involved her students in resolving the matter, asking them to review their view and see if there was anything
they wanted to talk about. The following excerpt shows how she started her KB Talk on 12th Oct (Segment Z-C-10/12):

“What we do in KB Talk is to talk about any questions, concerns you have. When you think about what we are doing in our database, the other thing is to talk about something of our problem of understanding that we are working on. Today we are going to look at the database, put it up on the screen . . . . When I put up the database, I want you to look at it and tell me if there is anything you want to talk about...We are having our KB Talk and our problem of understanding...”

Some of the students began to talk about the “cheese thread”; they actually noted the same problem the teacher saw. Zahra explained that the initiating question “wasn’t a bad question, but people went in a silly directions and that was the problem.” She then engaged the students in a discussion of about writing good notes, and reflected on this incident in a subsequent teachers’ meeting. She explained her next move in class at one of the weekly meetings, responding to her students’ reaction at the KB Talk (Z-M-10/12):

“I asked the kids to go back to look at all notes in the cheese string, and to go delete the ones that were silly and weren’t helping, and to put some of their notes into annotation instead of notes.”

She reflected in her journal on 26th Oct (Segment Z-J-10/26) on the outcome of the KB Talk aimed at getting students to work on really good questions to help classmates:

“At our KB Talk we agreed to make two new views – Gravity and Planets – and moved notes to them. This has eased up the space on Cycles and will, I hope, bring some focus to some of the excellent questions that are there.”
Zahra’s work in the Technology (T) problem space integrates issues regarding the curriculum and students’ ideas, student capabilities, social interactions, and classroom structures and constraints. For example, responding to the growing number of notes on her class’ view on Knowledge Forum, she first sat with her students and brought more focus to the topic of inquiry by creating new views to hold notes on related ideas, so as to ease up the space on the Knowledge Forum view and allow deeper inquiry (seen in segment Z-J-10/26 above). She then went a step further by engaging students in reflection on their notes, with the goal of advancing work from a Community Knowledge, Collective Responsibility perspective.

From her KB Talk on 6th Nov (segment Z-C-11/06).

“Grade 3, we are going to start now our KB Talk. And what I thought we could do today is some work that is really, really important in the Knowledge Building community. I need you to go back to your seat, and the work I am thinking about today is called bringing coherence to the view. And what coherence means is to try to make the view easier for people to understand, for you to understand and for people to have a look. So when I look at the view, I know it is about cycles. But now when I look at the view itself, what do you think? Do you have any idea what the view is about?”
The students brainstormed ideas to bring coherence to the view and decided to create new views for different sets of ideas.

As the inquiry unfolded Zahra ran a series of analyses of students’ participation on Knowledge Forum to determine what she was going to do next. She noticed her students’ irregular contribution on Knowledge Forum and identified a few possible reasons in one of her journal entries (Z-J-10/23 – Z-J-10/27):

“student A – 4; student B – 3; student C – 1; student D -1; student E -1 …etc; so 10 children did not write any notes.”

“I am finding that many kids are pretty unfocussed when on KF. Some spend time fooling around with the functions keys, getting up and talking to others and just not seeming that engaged in their KB work.”

“I wish these kids had never learned to make annotations! Need to talk to them about writing “I don’t get it” – they need to be more specific, or just close the note if they don’t have a theory about the problem being asked. Also – “I don’t (or do) know that.”

 “[O]ne child responded to another child’s annotation and wrote “p.s. you are cool!” So now we have children using annotations to “chat,” they are not even responding to the note.”

Based on these observations, she planned her next move, trying to get students to see the value of contributing good notes (Z-C-10/23).
“Tomorrow I’ll take the kids in ¼ group and work with them to go through all of their notes, delete annotations, move annotations into notes, move notes close to others about the same problem.”

After she did the “1/4 group” exercise, she entered another reflection in her journal (Z-J—10/26):

“This morning I sat with the most prolific writers (often of annotations, unfortunately), searched their notes, deleted annotations, made annotations into notes and vice versa and talked about what a problem it is when they are spending more time making annotations than notes. All looked a little sheepish and agreed to stop writing annotations unless it was really necessary.”

Though some of Zahra’s actions seem procedural, her broader agenda is clearly use of technology to advance ideas; *Community Knowledge, Collective Responsibility* is paramount. Although she had earlier decided that she needed to stop her students from using annotation, as it had affected the quality of knowledge building, she remained mindful of students’ responses and expanded her work in the *Technology* (T) problem space by analyzing students’ reading and writing patterns in addition to their contribution patterns. She noted in her journal (Z-J-10/22) that students who are not writing much were not reading much either:

In her journal in October (Z-J-10/22). “Everyone else has 7 notes or more. Want to sit with each of these children today and talk to them about a note idea, help them get it down. What is the barrier? Lack of focus? Typing skills? Ideas? Maybe they are not reading enough?”
Lack of engagement with the problems?”

Zahra continued to analyze her students’ participation pattern and generated ways to engage all students in more principle-based work:

In her journal entry on February (Segment Z J-2/5), "I may need to be more explicit about the importance of reading other’s notes and trying to improve their ideas by building onto them. I’ll run vocab and writing growth after our second session.”

The content and nature of her reflections were consistent. In February she continued to reflect and make plans based on students’ participation on Knowledge Forum. The following excerpt is her journal entry (Z-J-02/08):

“Next session – pay attention to how these children are spending their time on KF. Are they talking/ off task/ out of their seat? Part way through the session [I] ask them if they have made a note, and if they haven’t, ask why. See what the barriers might be for them, especially for student J and student T [both wrote o notes and also read less than others]. Maybe they would do better sitting on their own using a laptop? Student A also read quite a bit less than others. I think hers might be a focusing issue.”

Working at the intersection of the Social Interaction (SI) and Technology (T) problem spaces, Zahra explored Knowledge Forum’s Social Network Analyses:

Reflection in her journal in “This graph for reading, set at a threshold of 35, indicates that nine T~R, SI~R
January (segment Z-J-01/26) children are not as involved in the social network in terms of reading notes and having their notes read by others. Children in brackets (analysis data on Knowledge Forum) were not highlighted on the graphs above.”

She also explicitly reflected on the impact of Knowledge Building principles on her Students’ Capability if she improved their understanding of the principles. In a journal entry in February (segment Z-J-02/05-03) “Could do principles survey with them before and after, could also interview them to find out their attitude toward knowledge building, some of the barriers that might be getting in their way.” “Is there a difference between children who have a stronger sense of the principles – do they produce/participate more?”

In addition to engaging students directly in understanding Knowledge Building, she monitored the “intellectual energy” of the group and supported students in “rising above” to a higher view of their work in the Curriculum/Standards problem space.
Reflected in her journal in late January (segment Z-J-01/21-02) “Interest seems to have waned in the cycles, gravity and planet views. I’d like to do some work making rise-aboves and bringing coherence to those views. Maybe I can do that in ¼ groups this Thursday.”

“Today we sat together and looked at the cycles view and looked at the cycles view to identify as many problems of understanding as they could. Each child wrote his or her problems on a file card and I’ll hang these on the board.”

She did this so as to create a space for continual inquiry on cycle while starting a new topic.

There was no forced closure imposed for the topic on cycle. Instead, “rise-aboves” were created for both teacher and students to assess the collective learning. By doing this, Zahra has put in place a form of embedded and transformative assessment in an idea-centred environment.

5.4.3 Summary: case study #3 of Zahra (most experienced Knowledge Building teacher—five years of experience).

Throughout the inquiry on the topic of cycles, Zahra displayed great trust in the students’ capability to work with their ideas, and strong fidelity to idea-centred pedagogy. This was quite a contrast to what she defined to be the challenges/problems of a Knowledge Building practice in her one-to-one interview. In the interview, she explained (Annex A):

“There is nothing else I can focus on, because if I cannot get the kids to settle down and focus on what we are doing, then I can’t do anything else… but often the kids behavior is the first thing I have to attend to.”
This contrast is quite telling of the work of an experienced Knowledge Building teacher (in this case, Zahra). Contrary to the common notion that a Knowledge Building class is an anomaly in educational context, Knowledge Building teachers are seen here to have to deal with problems similar to those in regular classrooms. However, the problem spaces they choose to construct and focus on bring them on a different trajectory. As Zahra continued to plan the next inquiry topic, she showed consistency in bringing “students’ ideas” to the centre. This is made clear in the following reflection, which she entered into her journal at the start of her next inquiry:

“Next week for homework I’ll ask the children to pick the problem they are most interested in and find out more from: parents, family friends, relatives (maybe someone can come in and talk to the class); magazines, newspapers; own library, public library; tv, video; internet. Everyone had a turn on the database today. They also read about gravity and how the earth never stops moving [They each made notes] on a file card and I’ll hang these on the board.”

5.5 Summary of Three Case Studies

In reflecting on the case studies of the three teachers, we see a marked shift among teachers with different years of Knowledge Building experience. In Helen’s case study (with the least experience), she used specific structures and formats to ensure that the students understood the “what” and “how” of contributing in a KB Talk. Nancy, with mid-level experience, set curriculum plans that she then adjusted to accommodate student ideas. Zahra, with the most experience, took student ideas and engagement an important step further along the centrist-to-
relational continuum, with students’ ideas at the centre, and engaged students directly in principle-based work.
CHAPTER 6

Results (Part 3)

6.1 Teachers Operating as a Community to Construct and Explore Problem Spaces Related to Knowledge Building Classroom Practice

This chapter provides an analysis of teacher discourse from notes collected during weekly meetings. Each week throughout the school year, all 13 of the teachers at Jackman ICS, along with the principal, met to discuss advances and difficulties related to Knowledge Building pedagogy. In these meetings, teachers with one to eight years of teaching using Knowledge Building pedagogy shared experiences and offered solutions to each other’s problems. The meetings serve as the primary means of acculturating new teachers into the school-wide Knowledge Building community.

The discourse of teachers’ weekly meeting is analyzed to address the third research question: How do these teachers, as a community, identify and construct teaching problem spaces related to Knowledge Building classroom practice?

Twenty-two meetings were conducted in the year. Each meeting was framed by the following agenda: (a) identify problems of understanding. As indicated earlier, there is a continual effort to have students and teachers identify what they are finding challenging or difficult to understand. (This form of problem analysis has a strong basis in Knowledge Building communities supported by Knowledge Forum and the theory-building scaffold “I need to understand.”); (b) clarify knowledge advances; and (c) address technology issues. The analyses in this chapter focused mainly on teachers’ “problems of understanding,” and on interactions between teachers to support knowledge advances surrounding those problems.
As elaborated in Chapter 5, the problems teachers raise can be classified according to the five standard problem spaces: Curriculum/ Standards (C/S), Students’ Capability (SC), Social Interaction (SI), Classroom Structure & Constraints (CS&C), and Technology (T). However, as is evident in the interchanges presented below, conversations shift between these problem spaces at a fast pace, and the boundaries between “problems of understanding,” “knowledge advancement,” and “technological issues” become blurred, as group discussions lead invariably to work that is deeply relational in nature. In terms of a Knowledge Building community for professional development, going beyond best practice reflects a shift from a centrist to relational perspective. And as the analyses below suggest, ”going beyond” requires shifts as set out in Figure 2.10. In line with these shifts, obvious or evident features of classroom activity are reconstructed in ways that have teachers dealing with ill-defined problems, big ideas, and promising possibilities; routines give way to the generation of suggestions for novel approaches demonstrating adaptive flexibility; and procedure-based action is replaced by principle-based reflections.

The interchanges below revisit some of the problem spaces discussed in Chapter 5. As suggested there, even the least-experienced teacher shows a level of understanding beyond what might be expected from someone with no formal professional development in Knowledge Building pedagogy. To convey how these meetings support professional development, the excerpts below show interchanges involving all of them, as opposed to considering the independent work of Helen, Nancy, and Zahra as presented in the case studies in the previous chapter. Now we see how they work together to co-construct problem spaces, with attention to ways in which conversations allow all teachers to stay on a continual improvement trajectory. Thus, rather than a unidirectional framework for professional development, in which more-
experienced teachers pass on their wisdom and “best practices” to the less-experienced teachers, we see a teacher community as committed to engagement in Knowledge Building themselves as they are committed to engaging their students in these practices.

Four interchanges between teachers are presented below, selected to show how teachers consistently identify a significant teaching challenge and engage in creative problem solving. These examples illustrate how this teacher community is structured to allow everyone to advance, and how it contrasts with professional development designed to convey activity cycles, step-by-step routines, or other set procedures. Thus, when a newcomer inquires about the “steps to be used for a KB Talk,” more-experienced teachers convey practices that are not step-like—practices that have led them to continually refine procedures rather than follow a sequence of fixed steps. Further, as the experienced teachers reflect on the newcomer questions and offer advice, their reflections often lead them to suggest novel approaches that they themselves have not tried but will consider in an effort to refine their own practices.

Interchanges additionally convey ways in which the community acculturates new teachers into the school-wide teacher Knowledge Building community, which operates on the basis of emergent rather than fixed goals. In each episode, teachers reflect on their practice and co-construct plans as work proceeds. New teachers benefit directly from ideas generated in these sessions. Less evident, but also important, is the subtle spread of innovation. For example, in Chapter 5 we saw a teacher with mid-level experience use a duplo-block “invention” to convey to students the “build-on” features of a KB Talk. If we go back several years in teacher meetings, another teacher used the metaphor of “passing a ball” from one student to another to convey to students the need to carry work forward from one person to another in their KB Talk. It seems
unlikely that Knowledge Building practices would develop at the pace or with the effectiveness that they do within this school, without such informal spread of innovations. A challenge for the future is how to better record and more formally disseminate teacher innovations.

Table 6.1 provides an overview of meeting dates and the types of questions teachers pursued. The teachers came to these issues with many different perspectives. Questions dealing with the same issues were framed differently by different teachers in different contexts. Thus, the questions in Table 6.1 do not provide a verbatim account of teacher questions, nor do they attempt a one-to-one classification of problem spaces and problems discussed. Rather, they provide some sense of the overall thrust of those questions, based on different inputs and different ways of framing the problem statement, and they reflect knowledge advances based on inputs from teachers with up to eight years of experience. The verbatim account and full transcripts are presented in Annex D1-D4
Table 6.1. Overview of Meeting Dates and Problems Discussed at Teachers’ Weekly Knowledge Building Meetings that Correspond to Five Problem Spaces

<table>
<thead>
<tr>
<th>Meeting Dates</th>
<th>Problem Spaces</th>
<th>“Problems of Understanding”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 12 &amp; 17</td>
<td>Curriculum/ Standards (C/S)</td>
<td>When and how should a teacher “wrap up” an inquiry?</td>
</tr>
<tr>
<td>May 18</td>
<td>Students’ Capability (SC)</td>
<td>How do we assess how much students have learned at any point during an inquiry, so that we know how much of the intended curriculum has been covered?</td>
</tr>
<tr>
<td>Nov 11</td>
<td>Social Interaction (SI)</td>
<td></td>
</tr>
<tr>
<td>Jan 24</td>
<td>Classroom Structure &amp; Constraints (CS&amp;C)</td>
<td></td>
</tr>
<tr>
<td>Oct 12 &amp; 27</td>
<td>Technology (T)</td>
<td>What is the best way to handle superficial student work?</td>
</tr>
<tr>
<td>3 Nov, Feb 15,</td>
<td></td>
<td>How do we decide when to move on to a new topic of inquiry?</td>
</tr>
<tr>
<td>Apr 12 &amp; 26</td>
<td></td>
<td>What kind of questions are needed to start a KB Talk?</td>
</tr>
<tr>
<td>Oct 19, Nov 2,</td>
<td></td>
<td>What is the best way to manage a Knowledge Forum view?</td>
</tr>
<tr>
<td>Dec 14</td>
<td></td>
<td>How do we know if a Knowledge Building principle is coming alive in the classroom?</td>
</tr>
<tr>
<td>Feb 23</td>
<td></td>
<td>How can we encourage meaningful participation in a KB Talk?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>How do we respond to “the right answer” and not break the knowledge-building</td>
</tr>
</tbody>
</table>
momentum?

How can we ensure everyone participates in a KB Talk?

Is there a best way to conduct a KB Talk?

Are there steps to take in a Knowledge Building class?

When and how should we support “rise-above”?

In addition to discussing issues of the sort conveyed in Table 6.1, teachers used their weekly meetings to discuss matters such as conferences; visitors to the school; upcoming events, such as Green Week; and virtual conferences. They also discussed professional development opportunities and needs, along with the need for basic technology training. As can be seen from the dates on which these other topics were discussed (Sept 14, 21, 28; Nov, 10; Mar 8; and May 23), a wide variety of issues were raised in these meetings, intermixed with discussions focused on the five core problem spaces. These were not analyzed. The great majority of discourse in these meetings—over 90%—was devoted to issues of the sort presented in Table 6.1.

Below, teacher interchanges surrounding four of the questions in Table 6.1 are presented. These interchanges span the five problem spaces identified in Table 6.1. And, as reflected in discussions, in proposed solutions, in strategies, and in contemplation of new approaches, addressing such questions requires a relational approach. Input from teachers with up to eight years of experience resulted in discussions that moved flexibly between problem spaces, and that demonstrated collective relational efforts.
6.2 How Can We Encourage Meaningful Participation in a KB Talk?

Knowledge Building discourse can take place anywhere, in face-to-face informal snack-time conversation, in a more formal classroom discussion, or in ideas posted on Knowledge Forum. From the data, it is clear that this group of teachers considers KB Talk an essential component of knowledge-building discourse and Knowledge Building practices more generally. As such, KB Talk was a common topic of discussion at these weekly meetings.

The following conversation surfaced when the least-experienced Knowledge Building teacher asked what kind of questions they should use to start their students on knowledge building.

Responding to this, Ronny, the teacher with eight years of Knowledge Building experience, explained that the questions could come in various forms and were rather emergent (“if something comes up then it becomes…”).

Nancy, the teacher with three years of Knowledge Building experience, shared how she got her students to connect their questions about rats to what they observed of their pet rat in class. She wanted students to come up with questions that they were genuinely interested in. She explained that that there might be many reasons why students are not interested in a question, and that the teacher has to understand those reasons to keep students motivated.

Ronny added that this process of students owning the questions might happen later, as students need time to develop and process their ideas.

Nancy went on to share an example in her class that occurred when she tried to get them to study rats and their living conditions. The students were asking why it was that the rat didn’t drink from the silver-colored container, and they started to postulate some interesting theories--
e.g., it is not warm enough; I don’t think they like the silver. Once the students began to work on something with engagement, they conducted research during their library period; someone found out about using a special tray (the ‘pee tray’) used by rat, and the students wanted to test their ideas. The teacher went to the hardware store to get more information and supplies that would enable student investigations.

Nancy asked how she could ensure that she was guiding students in an inquiry involving important content knowledge. She felt that she had created an environment to support students in raising questions that interested them, and had helped the process by building up the rooms with books on rats. As suggested in the comment below, she reported that she was not anxious about content, suggesting that she was confident regarding her work on the Curriculum/Standards (C/S) problem space. She reflected on the way she should design lessons to ensure that students have sufficient opportunity to figure out their question. She was aware that she basically held control of how the lesson unfolded, as she reflected in her comments that students came up to her to suggest what they should do next. She ran through the various lesson ideas:

I didn’t think I focused on content...I have not been anxious about the content at all.

Nancy is also seen as a teacher willing to try various interventions, and modify her activities emergently (“...today, we have no laptop -- with the storm …network affected”). She was quite certain that the initial questions need not be constrained by content, but she was more interested to find out how to sustain Knowledge Building momentum.

Zahra reinforced the need to be aware of students’ knowledge-building efforts. Interestingly, she conveyed what might be perceived as a dilemma in classroom design: “maybe
interest starts to wane, maybe it is time to do a Rise-above, maybe….” Although her intention may not be clear, it suggests a clear relational goal involving students’ ideas and curriculum goals, where there is no necessary disconnect between students’ ideas and the

Curriculum/Standards (C/S) problem space.

This could indicate that more-experienced Knowledge Building teachers consider development of students’ ideas as more important than content coverage. But the story is surely more complex. Students in this school are doing well on standardized achievement tests and other measures of educational achievement, and teachers have no reason to believe that there is a tradeoff between development of students’ ideas and content coverage.

Zahra continued to focus on the development of ideas:

It is how the ideas grow and—I am also thinking hearing the way the children transcript showing the children in meaningful talk – that is not about content about how do you listen, how do their ideas grow – I think something else v worth letting David…. know: you might forget the content of the talk but it way [the talk is done].

In this segment, a teacher with limited experience wondered what kind of question she could use to kick-start Knowledge Building (a centrist approach). Through interchanges with other teachers, it became evident that it is important to engage students in identifying questions, that the process is emergent, and that there is often no single question, nor does there need to be. We take the last statement by the most experienced teacher to mean that from her perspective, getting students to present their “problems of understanding” as a starting point for advancing curricular goals is essential, as is creating a supportive environment. The content will come, the ideas will grow, and the curriculum standards will be addressed (a relational perspective). This
perspective is consistent with other comments she makes and with the fact that her students do well, as judged by curriculum standards.

6.3 How Do We Know if A Knowledge Building Principle Is Coming Alive in the Classroom?

In line with their commitment to Knowledge Building practice, teachers would regularly commit time during their weekly meeting to discuss specific Knowledge Building principles. In this meeting, the Knowledge Building teachers decided to explore the concept of “symmetric knowledge advancement” in relation to their own classroom work. This is an interesting segment, as we read about the teachers’ struggle to understand this concept, both for their own professional knowledge and for their students’ learning. Their understanding and the degree to which they reconcile the principle with their practice vary significantly according to their years of experience.

Nancy (three years of Knowledge Building experience) began by questioning whether they, as a teacher community, are practicing this concept in their work. Zahra (five years of experience) created another problem space by asking if there are real communities that achieve this. The more experienced teacher, Ronny, shared the original definition of “symmetric knowledge advancement” as one of Knowledge Building principles and recognized his own struggle with this particular principle. Nancy drew an analogy to themselves as teachers, advancing their knowledge both in class and within this teacher community. Zahra advanced their understanding further by defining the technological dimension of the principle-i.e., how students’ work across views on Knowledge Forum represent this principle.
Also, the measure in ATK that shows the kids are working across all the views. Would that be symmetric as well, that everybody is working on the same things (all the views) not just on theirs.

As the meeting progressed, the teacher moved on to discuss another Knowledge Building principle, *Rise Above*. Again, it elicited different interpretations from teachers with different years of Knowledge Building experience: Nancy explained the idea behind *Rise Above*, in that an idea perhaps needs to exist in a “certain messy state” before it can move into a “higher-level formulation.” Clara, a teacher with more than five years of Knowledge Building experience, provided an explanation grounded in the framework of an idea-centred classroom. She explained it as a point of epiphany, where “certain things come together to move to the next step.” Zahra pulled these ideas on *Rise Above* together and explained how this played out in her class.

we are getting it, they want to learn how to make *Rise Above*, the idea of what helps them to ... all those things seem OK …not just the epiphany part, we are experimenting, where are we now, so we keep going, it is the time where it comes together, and then move forward again.

Alice, the teacher with less than a year of experience, described a superficial feature of an idea-centred classroom: “someone said ‘actually now I have changed my mind, I am going with Sage’s idea.’” This was her indicator that students were working with ideas.

Exchanges like these show different interpretations of the role of Knowledge Building principles in their practice, from a more abstract understanding, a philosophical explanation, to
concrete manifestation of the principle in the classroom, The most unique interpretation came from Zahra (five years of Knowledge Building experience), an interpretation that connects explicitly to indicators on Knowledge Forum as well as its direct impact on her classroom work: “not just the epiphany part, we are experimenting…”

6.4 When and How Should We Support Rise-Above?

This conversation was sparked by a question from a first-year Knowledge Building teacher. Katie wanted to find out about Rise Above. Zahra explained how the use of rise-above notes had changed in her class over the year: (a) from Zahra leading the rise-above efforts to her students initiating them (“they were doing it in small groups by themselves”); and (b) from Rise Above being used to tidy up the view when her students were finished working on it to Rise Above being used at the start of the inquiry “as soon as there is a critical mass about anything.” She went on to share one of the new things she introduced to her class to increase students’ autonomy in their knowledge-building efforts. The students were encouraged to come forward to announce to the class when they saw a chance to create a rise-above, and their classmates were to stop working on the notes until the rise-above has been created. Zahra was prepared for this to go “totally crazy” or “totally rise to the occasion” (Annex D-2), but she was willing to give it a try. She had adopted a relational view of both the Technology and the Curriculum problem spaces – constantly looking for ways to work students’ ideas into the inquiry, to the extent of using Rise Above to assess how much was learned at each point.

When asked by the less-experienced teacher when she felt the students might want to create the rise-above, Zahra guessed that it would probably happen when the students felt that they had learned enough to write a summary note and move on, not to a final understanding, but
their most advanced effort to that point. This reveals a strong alignment to the principle of Community Knowledge, Collective Responsibility, that students need to monitor and understand the notes that existed on a view on Knowledge Forum, and not just their own notes. Katie, the less-experienced Knowledge Building teacher, drew a parallel to work in her class, where her students were tasked to work in face-to-face groups to establish their inquiry plan. She described it as the “nature of collaboration,” a less well-defined account of collaboration than the collective Knowledge Building Zahra envisioned in her class.

This interchange reveals how more-experienced teachers adapted their strategies—in this case rise-above strategies—to classroom events at each point of the inquiry. They might not always know the outcome of their implementation, but they displayed a high level of commitment on students’ ideas (relational view) to exploring how implementation of Knowledge Building principles might benefit their classes.

6.5 What Is the Best Way to Manage a Knowledge Forum View?

The following excerpts convey an interchange among teachers with one to eight years of Knowledge Building experience. They provide accounts of the obvious or evident features identified by teachers with limited experience, show how teachers with more experience address these matters, and reveal efforts at principle-based action that become more direct with experience.

The conversation started with a “problem of understanding” from an inexperienced teacher on how to manage her class’ Knowledge Forum view. The more-experienced teachers were able to break down the problem to a deeper analysis regarding students’ approach to their ideas on Knowledge Forum. The strategy adopted by the more-experienced teachers involved
adaptive flexibility to help students relate their ideas to the ideas of the class in order to resolve the problem before determining the procedures to adopt in class.

Nancy, with three years (mid-level) of Knowledge Building experience, mentions an obvious or evident feature of her classroom practice that she attributes to *Students’ Capability* and *Social Interaction*—what she refers to as unproductive notes and a chaotic or messy view on Knowledge Forum. She attributes this, at least in part, to student inexperience in Knowledge Building.

Part of what happened, of what is happening in database, it is really chaotic, we are also aware that we are just letting kids go in, not productive, [these] aren’t the kind of notes that really help them to build knowledge; I also know that some of them are new, and so I think some of [them] are innocent like they are not realizing what the goal is.

She explored possible strategies, stating them in terms of procedures (use of data projector and whole-group activity), with the latter indicating a possible attempt to address the principle of *Community Knowledge, Collective Responsibility*:

“We have been talking about how next to help them work on the database. We did talk about using the data projector and . . . how we can get as a whole group; I felt it has to happen as a whole group because they all have to know it.”

Moving on, the possibility that she was searching for a solution with a principle-based component is reinforced in the following comment:
“I am not sure I would like to work with them [that way], I want them to gain more understanding, the goal [is that] they are communicating.”

It does seem that the teacher is trying to engage students in a way that would allow them to take more responsibility for their work, as is consistent with her individual case study. Zahra (five years of Knowledge Building experience) followed up by sharing her experience with a similar problem. She was more certain and specific and clear that the procedure to be implemented needed to provide the infrastructure for the principle of *Idea Improvement*, giving ownership to students.

“We have a lot of notes that are like yes, no, why are you saying that?--notes that didn’t advance our idea.”

She went on to explore her strategies to achieve idea-centredness.

“We talked about every note that needs to have an idea in it. They can go right to the person to tell the person and talk to you.”

And recognition of the need for continual improvement was evident in her follow-up comment:

“Still in that process, I got some silly notes, this year this is a huge problem.”

Nancy, who started the conversation, continued to explore the problem that she and the more experienced teacher framed: “How did you get the students started to look at their own notes?”
Zahra, the more experienced teacher, continued to identify strategies for addressing the problem in light of *Improvables* principle, mainly from the students’ perspective, and riding on the affordance of Knowledge Forum (*Technology* problem space):

“We talked first, and they searched for their notes [that] they created just for this year. They put in the note, it is really easy.”

“it also gives them a sense of, you can refine the search, the note they created is always there to be improved.”

As the conversation continued, Rhonda (less than a year of Knowledge Building experience) identified a challenge related to a scaffold support in Knowledge Forum, that students are “really hesitant to say that they have a problem of understanding.” Ronny, the most experienced Knowledge Building teacher in the group (eight years) responded according to his own experience by reconstructing the problem to let students own their learning:

“I made it clear that you are not responsible for any follow-up to the questions on the database; the question will be worked on if there is an interest, [it is] not something they need to work on, we were just getting them.”

“…No, I don’t want children to think, oh, I have three questions and so I have to do three times more work; it is just to get all the questions and theory on there and see if people [are] interested.”
In this sequence, more-experienced teachers were able to relate problems to the Knowledge Building principles. In the case of “chaotic activities on Knowledge Forum view,” they encouraged the less-experienced teachers to look at the deeper feature involving concepts of students’ views of their ideas on Knowledge Forum. In the case of students not wanting to admit that they have a problem of understanding, they encouraged them to look beyond and see how to get students to own the problems. In general, the strategies adopted by the more experienced teachers was aimed at helping students generate and improve ideas, relate their ideas to the ideas of others, and experience a risk-free, supportive environment for idea improvement.

6.5 Summary of Analysis of Meeting Transcripts

Meeting transcripts revealed that teachers with different levels of experience construct similar problems spaces throughout their Knowledge Building practice, with the more experienced teacher conveying a much more elaborate and extensive repertoire of strategies from a relational perspective. For example, when the less experienced teacher asked about KB Talk, the discussion that followed indicated that all teachers view students’ ideas as important, but the inexperienced teacher focused on format and the question to kick-start the talk, while the more experienced teacher took a longer view of the challenge and focused on how to support idea generation and improvement in a community context. This kind of interaction opened up new possibilities for all teachers to advance their practices.

This interaction conveys some of what is meant by the claim that Knowledge Building operates on the basis of emergent rather than fixed goals. Creative knowledge practices require noticing and taking advantage of new opportunities rather than relying on fixed routines. Implementation requires the creative engagement of teachers to continually work with students’
ideas, and with each other, to improve classroom designs and practices, based on principles rather than scripted procedures. In turn, working with principles rather than fixed procedures requires systems that are very different from those established through activity cycles, step-by-step routines, and other set procedures.

It is hoped that the analyses of interactions among these teachers helps to clarify how the co-construction and reconstruction of problem spaces in a teacher community facilitates shifts from centrist to relational perspectives, as viewed in Figures 2.1. This represents a critical move from skillful practitioner to principle-based practitioner, as well as an important consideration in teacher professional communities. Sustained work to elaborate deep features of problems, adaptive approaches to the generation and implementation of strategies, and principle-based reflection within problem spaces represent necessary components of idea-centred pedagogy.
CHAPTER 7

Conclusion

7.1 Changes from Centrist to Relational Perspectives within Five Problem Spaces

Constructed and Explored by Teachers with Different Levels of Knowledge Building Experience

This thesis explores teaching practice as a function of years of experience (one to eight) with Knowledge Building pedagogy. It investigates the problem spaces constructed by teachers, and the means by which they achieve continual improvement in their practices while fostering continual improvement of students’ ideas. In an effort to provide a theoretically consistent and empirically based understanding of the pedagogical shifts that are necessary within these problem spaces, the analyses focus on an overarching dimension of change from a centrist to a relational perspective. The underlying belief, for the centrist perspective, is that the teacher’s procedures and presentation of content represent the primary determinant of effective action in these problem spaces; the underlying belief for the relational perspective is that students’ ideas and actions represent an underutilized resource and that effective action within these problem spaces requires turning over high-level controls to students so that they can act more effectively and responsibly. In essence, the relational approach requires effective action from both perspectives.

Both perspectives are meant to represent “good teaching” from a constructivist approach. The centrist perspective is reflected in the teacher’s construction and elaboration of problem spaces that establish effective curriculum plans, social interaction patterns, expectations, or other “best practices” as used by skillful teachers. The relational perspective is reflected as reinvention
of those plans, interaction patterns, expectations, and so forth, as work proceeds to accommodate student input and shared responsibility. This centrist-to-relational shift is used to characterize three embedded shifts, all of which need to be made to foster Knowledge Building pedagogy: (a) surface to deep interpretation of problems and processing of information; (b) routine to adaptive approach to classroom activities and student engagement; and (c) procedure-based to principle-based reflective action. Accordingly, in Knowledge Building, construction and elaboration of the problem space represents a dynamic, ever-changing enterprise.

Teachers’ in-service and pre-service courses have traditionally focused on pedagogical content knowledge (Schulman, 1972), and recently, there has been the inclusion of technological-pedagogical content knowledge (Mishra, 2005) in relation to the networked environment. As such, the courses seldom emphasize problem solving except through real action in practicums and internships. Situated problem solving is influenced by many factors (e.g. personal experience, intuition), and may not always be consistent with cognitive theories of learning. The starting point of this study was that skillful teaching, as currently represented in the literature, provides a model of effective constructivist pedagogy. Hence, the literature review was used to identify characteristics of skillful teachers and Knowledge Building teachers that fall within the same teaching problem spaces: Curriculum/Standards (C/S), Social Interaction (SI), Student Capability (SC), Classroom Structures and Constraints (CS&C), and Technology (T). It then used the literature of cognitive studies to identify problem-solving processes: i.e., construction and exploration of the problem spaces associated with the three shifts that were identified, to provide a finer-grained analysis of good teaching and dimensions that might distinguish skillful and Knowledge Building teachers.

Below is a summary of results related to the three research questions.
7.1 Results for Research Question 1 (Chapter 4): What kinds of problem spaces do Knowledge Building teachers construct and explore?

Thirteen teachers were interviewed regarding their teaching practices and experience with Knowledge Building pedagogy. Their responses could be readily aligned with the five core problem spaces common to the skillful teaching model. As 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.

7.2 Results for Research Question 2 (Chapter 5): How do individual teachers, as reflected in individual case studies, construct and explore teaching problem spaces related to Knowledge Building practice?

Analyses revealed that the teacher with the least experience focused on students’ behavior, procedures, and protocols more than on the substance of students’ ideas. There was clear evidence of efforts to establish an idea-centred classroom, but as problems arose, attention was drawn to establishing effective classroom procedures rather than analysis of students’ ideas. It was as if there were too many demands for teacher attention, so while there was implicit understanding of Knowledge Building principles, the inexperienced teacher did not explicitly engage in problem solving in light of them. Nonetheless, she recognized the need to advance on
more fronts, and her procedures did not limit that potential, but rather represented steps in a series of risk-taking efforts to advance students’ ideas.

The teacher with mid-level experience (three years) focused more on students’ ideas, integrating them into her predetermined curriculum plans and activities. It was seemingly the effort to create an idea-centred classroom that led her to embrace high levels of uncertainty over an extended period of time, as a child tried to work through a misconception. In the end, she seemed to face a choice—directly correct the misconception or not—as she could see no way to better balance curricular demands and students’ ideas.

Zahra, the teacher with the most experience, displayed great trust in the students’ capability to work with their ideas, and strong fidelity to idea-centred pedagogy. She conveyed to her students a need to clarify and advance their ideas, and engaged the community in that process, so that she was not the arbiter of ideas but rather a helpful team member engaged in idea improvement. Thus, she engaged individual students in raising the quality of their notes; and she engaged the community in a collective review of their knowledge advances, by projecting their ideas on an overhead screen. She talked with students about their collective work, and conveyed to them an understanding that they bore collective responsibility for it. To that end, she engaged students in review and refinement. Her students thus gained better understanding of the importance of constructive criticism, and could operate as a team to advance their community space. She also dealt with behavioral and procedural issues, as all teachers must. As she explains,

... if I cannot get the kids to settle down and focus on what we are doing, then I can’t do anything else… but often the kids’ behavior is the first thing I have to attend to.
Overall, teachers construct and explore problem spaces relevant to Knowledge Building within the same frameworks used by other teachers. What distinguishes them, and places them on a different trajectory, is the shifts to more relational perspectives conveyed in Figures 2a-c as presented in Chapter 2. Accordingly, we see a general shift from teachers constructing and elaborating problem spaces surrounding procedures aimed at supporting students’ ideas and inquiry, to one where the community itself is better positioned to assume the challenge of idea improvement. To this end, problem spaces become embedded within one another and deeply interconnected, so that rather than being pulled in different directions, teachers are working within a coherent system.

7.3 Results for Research Question 3 (Chapter 6): How do teachers, as a community, construct and explore teaching problem spaces related to Knowledge Building classroom practice?

Transcripts of teacher meetings revealed, at the most general level, that the great majority of meeting time is committed to raising important issues about practice, about translating theory into practice, and about operating as a team to address significant pedagogical issues. Teachers establish for themselves the sort of self-sustaining community that they aim to establish for their students.

Research suggests that in weak teacher communities, innovative teachers become demoralized because there is no community support (Talbert & McLaughlin, 2002). That is certainly not the case at Jackman ICS. Teachers engaged in supportive discourse with one another and work collaboratively to address challenges. They also engage in a variant of what
Huberman (1993, p. 28) refers to as the “strongest incentive for collaboration.” He identifies this incentive as exchange of “instructional materials and formats.” What is different in the current community is that the exchange is not primarily around instructional materials and formats, but rather around ways of eliciting and sustaining idea advancement surrounding students’ ideas. These ideas are at the center of the enterprise. The demanding work that follows is to keep ideas advancing in ways that allow students to go beyond standards; so instructional materials, formats, and procedures are to be extended, not viewed as the benchmark to which everything conforms.

Other research shows that teacher collaboration is infrequent, irregular, and haphazard (Brook et al, 2007). Again, the contrast to the teacher community reviewed here is striking, as interaction is frequent, takes many forms, and is integral to how the community operates. There is not so much sharing of resources and formats as there is creative problem solving, across problem spaces and in light of an “ideas at the centre” framework. The discourse is fundamentally relational. An essential challenge, revisited frequently in the episodes presented in Chapters 4-6 and in the full transcripts presented in the appendices, is what appears at a surface level as a tension between content goals and work with students’ ideas. Many researchers and practitioners see the solution as rather simple. If curriculum goals and students’ ideas are in opposition, favor the procedures, lessons, and routines to get to curriculum goals as efficiently as possible. In the teacher Knowledge Building community, the effort is more like that found in knowledge-creating organizations where ideas outside the normal range and those at the cutting edge are cultivated. Ideas at the intersection of personal interests, problems of understanding, and promising novel perspectives are viewed as important for meeting organization goals. Within the educational problem spaces presented in this thesis, they are powerful for advancing the
Curriculum/Standards (C/S) problem space. Clearly, a much more extensive program of research is required to understand the relational perspective whereby teachers address content goals and work with students’ ideas.

Consistently, the questions teachers raise fall within the problem spaces addressed by skillful teachers. What appears to distinguish Knowledge Building teachers, especially those with greater experience in Knowledge Building pedagogy, is the relational perspective whereby they work with emergent rather than fixed goals. As their interactions suggest, they continually notice and take advantage of new opportunities rather than relying on fixed routines. They work with each other to improve classroom designs and practices, based on principles rather than scripted procedures, and working within complex, dynamic systems in which they co-construct and reconstruct problem spaces in a teacher community. They shift to work with deep features of problems, to generate adaptive approaches, and to engage in principle-based reflection.

7.4 Consolidated Findings

Teachers displayed a shift from routine to adaptive flexibility, figuring out novel approaches to work around structural constraints. Their centrist-to-relational shifts suggest that shallow-to-deep interpretation, in the Student Capability problem space, was less dependent on number of years of experience than shifts from procedure- to principle-based reflection in the problem spaces Curriculum/Standards and Technology. The problem space constructed, as well as the kinds of shift discussed, by individual teachers are consistent with those constructed collectively in the teachers’ community meetings.

7.4.1 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.

7.4.2 Shifts within problem spaces.

The findings suggest that Hubert and Simon’s model of problem spaces, especially the postulation of breaking down complex problems into manageable sub-problems, needs to be adapted for practical teaching problems in a Knowledge Building classroom, which is constantly exposed to new information and ideas from students. There needs to be a shift in the problem space when dealing with complex classroom problems--more than breaking these complex problems down to smaller problems. The model offered in this study, as presented in Figures 2a,b, and c, Chapter 2, provides some indication of the shifts needed to support emergent processes.

7.5 Contribution of this Study
With the World Wide Web, teachers today can read about all the learning theories, retrieve lesson ideas from all over the world, and get teaching resources, all within a click of a button. This connectedness to the rest of the world means that teachers can quickly pick up the latest educational trend or the latest educational lingo, and use sophisticated terms in their daily work. In my experience as an educational policy-maker, I am constantly impressed by the vocabulary and the fluency of teachers when they describe their classroom work to me.

We no longer argue over the virtue of teacher-centred pedagogy, but this awareness of educational research and development does not necessarily translate into good teaching. Reading and hearing about Knowledge Building principles hardly means that teachers are able to practice the Knowledge Building pedagogy. It has become critical for us to understand, at a detailed level, the differences between various forms of good teaching and Knowledge Building pedagogy. As one of the teachers in the current research study lamented during a corridor conversation, “When we attend conferences and hear what other people are doing in terms of constructivist teaching and learning, we realize the idea-centred concept is so revolutionary, but when people hear about what we do in class, they would be saying, ‘oh, that’s just good teaching!’ How do we tell people what we are doing is different?”

The centrist view of problem spaces as elaborated in this study represents ‘good teaching’--a constructivist approach that extends beyond didactic traditional teaching. The contrast between centrist and relational approaches highlights the relational perspective at the heart of idea-centred knowledge building practice. Through the centrist and relational perspectives defined in the problem space model, this study helps to convey knowledge building principles in practice and provide a framework for professional development that will help teachers adopt idea-centred pedagogy in the following ways:
(i) The problem space model can be translated to a rating scheme that maps the change of teaching practice onto the centrist and relational perspective in the five problem spaces. It allows teachers to reflect on the change in their practice through the way they manage and solve problems in their classroom over time.

(ii) The problem space model can also be adapted to identify possibly observable stages or points in the progression of Knowledge Building practice that could be used to advance professional development for Knowledge Building pedagogy. The three dimensions of problem space in the five problem spaces should provide a comprehensive mapping of the teachers’ knowledge building practice without compromising the complexity of the practice. This will then allow a more in-depth definition of the model of Knowledge Building teacher over time.

7.6 Suggestions for further research

This study explores teaching practice as a function of years of experience (one to eight) with Knowledge Building pedagogy. It has implications for teachers’ pre-service and in-service training, but to be usable in that context, it will be necessary to demonstrate shifts within problem spaces as actually carried out by teachers through their daily engagement with students. Also, there is a need for a much larger sample size, both to increase the degree of generalization of the model and to provide a more effective range of examples in more varied contexts. Different cognitive frameworks or other data-gathering methods might have revealed different findings. This proposed extension would also help with integration of the findings of this study into current professional development models, which are mostly designed to improve teachers’ knowledge base, mainly pedagogical content knowledge.
This study identifies processes within 5 problem spaces. Future research is needed to update the types of problem spaces (for example, to include an assessment problem space) and to further explore the problem spaces identified (for example, to include a social media framework for the technology problem space).

Analyses of transcripts from teachers’ meetings indicate that teachers engage in extended discussions related to problem spaces surrounding knowledge building practice. These transcripts provide examples of teacher engagement in 5 problem spaces, with examples of Knowledge Building practice from kindergarten to grade 6. During these sessions teachers identify problems they would like to discuss, generate possible solutions, revisit issues they have faced at different points in time, and show a genuine interest in the work of their peers. For example, as the meetings proceeded from week to week teachers followed up with one another on issues reported earlier and conveyed an eagerness to receive updates regarding how a particular solution worked and what new issues arose. A great deal of their work is negotiated within a community model, as reflected in these teacher meetings. Teacher’s individual journals and classroom activity show follow-up action surrounding ideas negotiated in the group meeting. Overall, teacher involvement reveals many connections between community and individual work. These interactions, along with parallels in work in the 5 problem spaces uncovered in individual and community data, suggest that the community dimension is strong and important in principle-based reflection and a primary contributor to knowledge advances. Further study is needed to understand a sustained community model as the main mode of professional development for Knowledge Building pedagogy.
Reference


Scandura, J.M. (1981). Problem solving in schools and beyond: Transitions from the naïve to the neophyte to the master. Educational Psychologies, 16(3), 139-150.


