
KNOWLEDGE BUILDING GALLERY



TEACHING FOR DEEP UNDERSTANDING AND COMMUNITY KNOWLEDGE CREATION

**A collection of foundational KB practices
and teacher innovations**

KNOWLEDGE BUILDING GALLERY
LEADING STUDENT ACHIEVEMENT:
NETWORKS FOR LEARNING PROJECT

Written by: Monica Resendes and Karen Dobbie

Edited by: Denis Maika, Elaine Hine, Elaine Heaver, Leanne Ma, & Laura White.

Web Version developed by: MediaFace

KNOWLEDGE BUILDING GALLERY

YOUR PRACTICE PALETTE

INTRODUCTION

The Knowledge Building Gallery is a collection of concrete tools and strategies for teachers and educational leaders to use to support KB work. Grounded in Knowledge Building theory, this resource features innovations for practice created by and for new and experienced Knowledge Building practitioners. It also includes a variety of instructional tools and strategies from existing resources such as [Natural Curiosity](#) (2011), and [The Learning Exchange](http://www.thelearningexchange.ca) (www.thelearningexchange.ca) that provide tips for Knowledge Building. The practices and ideas described here are adaptable to different subjects and Grade levels, with the goal of engaging each and every learner as a valued member of a Knowledge Building community.

HOW TO USE THIS BOOK

This resource offers practical examples of Knowledge Building activities and instructional strategies. It also leverages all the wonderful resources that are already out there about Knowledge Building by linking to websites, documents, videos, and podcasts that help bring the ideas in this resource to life. In this way, this handbook is also a reference guide to many of the great KB multimedia resources already in existence. The following page provides an overview of the multimedia resources mentioned throughout this text for quick and easy access.

SECTION BREAKDOWN

The first section provides a brief overview of the history and development of Knowledge Building theory and pedagogy. The second section is dedicated to Getting Started with KB, and includes discussion on how to develop a Knowledge Building culture in the classroom, as well as ideas for great KB hooks. The subsequent sections focus on Gaining and Sustaining Momentum, and explore some foundational KB practices, including KB Circles, KB Discourse, and the use of Knowledge Forum technology to support creative work with ideas. The section on Assessment and Evaluation features practical tools and examples of assessment practices and activities that can be used by both students and teachers throughout the course of their KB work. In this section, we also touch upon ways to approach evaluation and reporting. Finally, the resource also includes a more in-depth discussion of the question, Why Knowledge Building, Why Now? In this section, we explore the theoretical basis of Knowledge Building in more depth, elaborate on the critical concepts and ideas informing the pedagogy, and provide a brief summary of some key research findings.

The companion KB Case Studies, also available for download on [The Learning Exchange](http://www.thelearningexchange.ca) (www.thelearningexchange.ca), tell the stories of Knowledge Building communities from SK to Grade 12, system leads to Principle Learning Teams, in teachers', and educational leaders', own words.

KNOWLEDGE BUILDING MULTIMEDIA RESOURCE SUMMARY

Websites

The Learning Exchange www.thelearningexchange.ca

KB Singapore www.kbsingapore.org

Natural Curiosity www.naturalcuriosity.ca

Knowledge Building Insights from Educators

Found on The Learning Exchange at www.thelearningexchange.ca

Knowledge Building Trailer

<http://thelearningexchange.ca/videos/knowledge-building-trailer/>

Glenn Wagner (Senior Division)

<http://thelearningexchange.ca/projects/knowledge-building/?pcat=999&sess=4>

Austin Kjorven (Intermediate)

<http://thelearningexchange.ca/projects/insights-inquiry-classroom/?pcat=1102&sess=0>

Jason Frenza (Junior Division)

<http://thelearningexchange.ca/projects/knowledge-building/?pcat=999&sess=9>

Bev Caswell (Junior Division)

<http://thelearningexchange.ca/projects/knowledge-building/?pcat=1102&sess=7>

Carol Stephenson (Kindergarten)

<https://vimeo.com/45603301>

<http://thelearningexchange.ca/projects/knowledge-building/?pcat=999&sess=8>

Knowledge Building Insights from Marlene Scardamalia

Found on The Learning Exchange at www.thelearningexchange.ca

All Inquiry is Not Created Equal

<http://thelearningexchange.ca/videos/all-inquiry-is-not-created-equal/>

Why Knowledge Building?

<http://thelearningexchange.ca/videos/why-knowledge-building-2/>

The Genesis of Knowledge Building

<http://thelearningexchange.ca/videos/the-genesis-of-knowledge-building/>

Scaffolds and Theory Development

<http://thelearningexchange.ca/videos/scaffolds-and-theory-development/>

Generating New Ideas

<http://thelearningexchange.ca/videos/generating-new-ideas/>

Advancing Ideas in the World

<http://thelearningexchange.ca/videos/advancing-ideas-in-the-world/>

The Tipping Point

<http://thelearningexchange.ca/videos/the-tipping-point/>

Student Well-being

<http://thelearningexchange.ca/videos/student-well-being/>

Student Agency

<http://thelearningexchange.ca/videos/student-agency-2/>

Empowerment through Community Relationships

<http://thelearningexchange.ca/videos/empowerment-through-community-relationships/>

Discourse in Math

<http://thelearningexchange.ca/videos/discourse-in-math/>

Knowledge Building Circles

Grades 1 and 4 courtesy of the Natural Curiosity Video Series on Vimeo

<https://vimeo.com/user11518284>

Grade 1: <https://vimeo.com/42169148>

Grade 4: <https://vimeo.com/58503126>

Grade 5: <https://vimeo.com/108100267>

Knowledge Builders Podcast Series

Podcast series, listening guides, and photo gallery found on The Learning Exchange at www.thelearningexchange.ca

Episode 1 – Innovation at Work: Exploring the KB Principles

http://thelearningexchange.ca/projects_audio/knowledge-builders-podcast-series/?pcat=999&sess=0

Episode 2 – All Ideas are Improvable

http://thelearningexchange.ca/projects_audio/knowledge-builders-podcast-series/?pcat=999&sess=1

Episode 3 – Every Voice Counts in Creating New Knowledge

http://thelearningexchange.ca/projects_audio/knowledge-builders-podcast-series/?pcat=999&sess=2

Episode 4 – The Power of a KB Community

http://thelearningexchange.ca/projects_audio/knowledge-builders-podcast-series/?pcat=&sess=3

Innovations in Thinking and Learning

Found on The Learning Exchange at <http://thelearningexchange.ca/itl-project-home/itl-project-reflections/>

Reflections and Lessons on KB: Mubina Panju and Angela Hoffman – Grade 1

Grade 1 Teacher Reflecting on Knowledge Building

<http://thelearningexchange.ca/videos/grade-1-teacher-reflecting-on-knowledge-building/>

Primary Teacher's Reflection on Knowledge Building

<http://thelearningexchange.ca/videos/primary-teachers-reflection-on-knowledge-building/>

Getting Started with Knowledge Building

<http://thelearningexchange.ca/videos/getting-started-with-knowledge-building-2/>

Knowledge Building Driven by Collective Ideas

<http://thelearningexchange.ca/videos/knowledge-building-driven-by-collective-ideas/>

Reflections and Lessons on KB: Elaine Heaver – Grade 6

Digging Deeper with Student-led Inquiry

<http://thelearningexchange.ca/videos/digging-deeper-with-student-led-inquiry/>

Families as Partners

<http://thelearningexchange.ca/videos/families-as-partners/>

Mars Mission - Grade 6 Knowledge Building Experience

<http://thelearningexchange.ca/videos/mars-mission-grade-6-knowledge-building-experience/>

Students Reflect on Inquiry-Based Learning

<http://thelearningexchange.ca/videos/students-reflect-on-inquiry-based-learning/>

Reflections and Lessons on KB: Allison Kemper – Grade 7

How to Create a Knowledge Building Inquiry

<http://thelearningexchange.ca/videos/how-to-create-a-knowledge-building-inquiry/>

Knowledge Building in a Grade 7 Classroom

<http://thelearningexchange.ca/videos/knowledge-building-in-a-grade-7-classroom/>

Reflections and Lessons on KB: Pieter Toth – Grade 12

A Transferable Process

<http://thelearningexchange.ca/videos/a-transferable-process/>

Reflections and Lessons on KB: Audrey Hensen – Leadership

Connections to Knowledge Building

<http://thelearningexchange.ca/videos/connections-to-knowledge-building-2/>

Rapid Failure as an Opportunity to Learn

<http://thelearningexchange.ca/videos/rapid-failure-as-an-opportunity-to-learn/>

Reflections and Lessons on KB: Suzana Milinovich – Grade 6

Assessment in a Knowledge Building Mathematical Classroom

<http://thelearningexchange.ca/videos/assessment-in-a-knowledge-building-mathematical-classroom/>

Knowledge Building in a Grade 6 Mathematics Class

<http://thelearningexchange.ca/videos/knowledge-building-in-a-grade-6-mathematics-class/>

Knowledge Forum Fosters Student Ideas

<http://thelearningexchange.ca/videos/knowledge-forum-fosters-student-ideas/>

Powerful Ideas on Knowledge Building in Mathematics

<http://thelearningexchange.ca/videos/powerful-ideas-on-knowledge-building-in-mathematics/>

Vocabulary in a Mathematics Classroom

<http://thelearningexchange.ca/videos/vocabulary-in-a-mathematics-classroom/>

Knowledge Building in Mathematics

Found on The Learning Exchange at <http://thelearningexchange.ca/projects/math-in-action/>

Math in Action: Paula Molloy – Grade 7/8

Agents of Change

<http://thelearningexchange.ca/videos/agents-of-change/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Benefits of Maker Space

<http://thelearningexchange.ca/videos/benefits-of-maker-space/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Co-constructing Learning: Teacher Perspective

<http://thelearningexchange.ca/videos/co-constructing-learning-teacher-perspective/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Building a Community of Learners: A Principal's Perspective

<http://thelearningexchange.ca/videos/building-a-community-of-learners-a-principals-perspective/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Maker Space Mindset

<http://thelearningexchange.ca/videos/maker-space-mindset/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Growth Mindset

<http://thelearningexchange.ca/videos/growth-mindset/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Thinking Like a Mathematician

<http://thelearningexchange.ca/videos/thinking-like-a-mathematician/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Math Connections

<http://thelearningexchange.ca/videos/math-connections/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Math Tools

<http://thelearningexchange.ca/videos/math-tools/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Home and School Connections

<http://thelearningexchange.ca/videos/home-and-school-connections/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Edible Math

<http://thelearningexchange.ca/videos/edible-math/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Student Thoughts on Checking In

<http://thelearningexchange.ca/videos/student-thoughts-on-checking-in/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Assessment and Evaluating Inquiry in Math

<http://thelearningexchange.ca/videos/assessment-and-evaluating-inquiry-in-math/?pcat=&psess=&ptit=Math%20in%20Action&ps=math-in-action>

Knowledge Building Case Studies

Found on The Learning Exchange at <http://thelearningexchange.ca/wp-content/uploads/2017/04/Knowledge-Building-All-Case-Studies-Accessible.pdf>

Knowledge Forum Youtube Tutorials

<https://www.youtube.com/playlist?list=PLNdWjAw9WQK0keMvP4YBCQxmIIZXAYqnK>

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Editors

Elaine Heaver
Elaine Hine
Leanne Ma
Denis Maika
Laura White

Contributors

Lindsay Butson
Jason Frenza
Elaine Heaver
Rhonda Hergott
Nizam Hussain
Suzana Milinovich
Paula Molloy
Glenn Wagner
Laura White

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INTRODUCTION

KNOWLEDGE BUILDING: THE THEORY IN A NUTSHELL



WHY KNOWLEDGE BUILDING, WHY NOW?

- Knowledge Building (KB) theory and practice is inspired by looking at **how knowledge creating organizations actually operate and how they create new knowledge out in the world** (knowledge creating groups can be scientific think tanks, commercial design labs, networks of software engineers, artist collectives, a community of American Civil war historians, etc.).
- **The primary job of knowledge workers is to work creatively with ideas** and produce knowledge artifacts that advance knowledge for the common good. The knowledge artifacts they produce can include anything from designs, to models, problem-solutions, theories, improved products, better procedures, and advanced technologies.
- **Capacities for creative knowledge work are in high demand in the 21st century.** More and more, the social, economic and political well-being of modern societies will rely on the capacity of their citizens to be able to innovate and work creatively with knowledge across all fields (OECD, 2008).
- As stated in the Ontario Ministry of Education’s document Growing Success, “Education directly influences students’ life chances — and life outcomes.
- There is a strong moral imperative for immersing students in authentic knowledge work from the earliest Grade levels. It is a long-standing reality that the level of knowledge students come to school with generally corresponds to the level that they leave school with. Education has not succeeded in closing this gap. **Growing students’ capacity for knowledge work seeks to even the playing field and help to set all students up for success.**
- The capacities for creative knowledge work also include social and collaborative skills that are built from a strong sense of empathy, open-mindedness and healthy communication habits; this in turn **helps students develop themselves socially and emotionally as well as academically.**

Knowledge creating organizations have what they call collective intelligence — a type of knowledge that can only be described *at the group level*. The collective work drives innovation.

In successful knowledge-creating organizations, innovation is not only the driving force, but it is “part-and-parcel of the ordinary, if not routine” (Drucker, 1985).

SO WHAT IS KNOWLEDGE BUILDING?

- Knowledge Building pedagogy is based on the premise that **authentic, creative knowledge work can take place in classrooms starting with the youngest students.**
- Knowledge Building is grounded in the **12 KB Principles** that are the foundation of the pedagogy (Scardamalia, 2002). The principles can also be thought of as **the 12 habits of highly creative teams.** They represent the key qualities, traits, and dynamics that characterize knowledge creation organizations of all kinds (see pgs. 20-22 for more information).

Real Ideas, Authentic Problems
Improvable Ideas
Idea Diversity
Epistemic Agency
Democratizing Knowledge
Pervasive Knowledge Building
Rise Above

Symmetric Knowledge Advance
Knowledge Building Discourse
Embedded, Concurrent,
& Transformative Assessment
Constructive Use of Authoritative Sources
Community Knowledge,
Collective Responsibility



“If it had to be summed up in one sentence, Knowledge Building could be described as **giving students collective responsibility for idea improvement.**”

IDEA IMPROVEMENT!

- At the beginning stages of any creative project, ideas can be a dime a dozen — this is as true in schools as it is in professional worlds. But KB is very much focused on “the hard part,” on moving forward in a promising direction and *improving ideas* over time.
- **Idea improvement is a foundational KB principle, as well as a socio-cognitive norm** that permeates the life and workings of a Knowledge Building community. In KB, students are responsible for not only improving their own ideas but also for *contributing to advancing the ideas and knowledge of the community as a whole.*
- Idea improvement and knowledge advances can sometimes take the form of great breakthroughs (such as Einstein’s theory of relativity), but most often, idea improvement happens in small increments and thanks to contributions from many different people. Everything from scientific theories to public policies to smartphones have advanced due to the collective effort of communities dedicated to improving ideas.
- For a community of learners, the creation of new knowledge constitutes any collective knowledge advances that are new to that particular community.

LEARNERS WORK ON AUTHENTIC PROBLEMS OF UNDERSTANDING

- Students work on problems of understanding that are truly authentic and meaningful to them (e.g., Why is the Arctic melting, what can we do about it? How does space exploration affect our daily lives? How are rainbows made?).

LEARNERS SHARE COLLECTIVE RESPONSIBILITY FOR KNOWLEDGE ADVANCEMENT

- In Knowledge Building, the **students are expected to increasingly take on the kinds of high-level responsibilities that have been traditionally reserved only for the teacher** — with help and support from the teacher, technology, and their peer community.
- A distinction between Knowledge Building and other educational approaches is **the imperative for every member of a classroom community to be contributing and advancing collective, public knowledge**, rather than just their own individual learning.

LEARNING AND KNOWLEDGE BUILDING – AN IMPORTANT DISTINCTION!

- **Learning is a very different phenomenon than Knowledge Building/knowledge creation.** Learning often refers to an internal and invisible process that goes on within an individual and is geared towards producing changes in individual belief or attitude; Knowledge Building is an overt activity that produces **knowledge and ideas that have a public life**. It refers to a **collective enterprise** as opposed to an individual mental process.
- **From a Knowledge Building perspective, learning inevitably occurs as a by-product of engagement in creative knowledge work.** It is virtually impossible for a student to be participating in authentic knowledge creation and not be learning at the same time.
- **Studies show Knowledge Building boosts achievement** in the following areas: basic literacies such as reading and writing as well as disciplinary literacies (e.g., science, math, history, engineering, language arts, chemistry, phys. ed., social studies, the arts), and epistemic literacies (e.g., how scientific knowledge is created) (Chen & Hong, 2016). KB research spans K-12, professional learning contexts, and four continents, including urban, rural, mainstream and Aboriginal contexts (Scardamalia & Egnatoff, 2010).
- **Students love to do it!** Motivation skyrockets, conversations at the dinner table change, and behavioural issues disappear when students can pursue creative work on issues they are passionate about, and when they feel that they are valued contributors to a supportive and dedicated community that is bound together by common goals.



“I really enjoy that there’s a community I can rely on, and I enjoy that I’m doing something that involves my passion, and it doesn’t feel like work!” — *KB student*

“It feels like my opinion is more valid and it boosts my confidence knowing that people are listening to me” — *KB student*



NONE OF US IS AS SMART AS ALL OF US! — JAPANESE PROVERB

GROWING A KNOWLEDGE BUILDING CULTURE

CULTURE AND CLIMATE

Knowledge Building is fundamentally a social and collaborative process. It requires the whole community to nurture a classroom culture that values wonderment, deep thinking, diverse ideas, inclusivity and equity, perseverance, honesty, and risk-taking. Knowledge Building thrives in a culture of **psychological safety** — a place where students feel that they can contribute their ideas and thoughts without judgment. Knowledge Building is not about getting at the right answer as quickly as possible, but about improving ideas and advancing collective knowledge on problems and questions of value to the community. Knowledge Building focuses on cultivating the types of habits of mind and practice that characterize creative experts and knowledge creating organizations, and engaging students in these processes in the classroom from the earliest Grade levels.

Climate and culture are key to creating a healthy and thriving Knowledge Building community in the classroom. Immersing students in a culture of authentic knowledge creation helps them to develop the capacities, skills, and knowledge they will need as 21st century citizens. It also gives students the opportunity to puzzle and problem solve through issues and ideas that they truly care about, to be connected to a dedicated community, and to flourish as individuals who are all unique, important, and valued contributors to a collective enterprise.













On the pages that follow, we point out the key cultural conditions and community norms that a Knowledge Building classroom needs in order to be successful. Specifically, we discuss the **12 Knowledge Building Principles, the Most Important Elements of a KB Classroom, The Teacher’s Role**, as well as some fun **Collaborative Strategies and Practices** to help start building a vibrant KB community. In the end, we want to create a collective mindset and culture based on the belief that ...

WE’RE NOT GOOD UNTIL WE’RE ALL GOOD!



THE 12 KNOWLEDGE BUILDING PRINCIPLES: A FRAMEWORK FOR PRACTICE & CLASSROOM NORMS

The **12 KB principles** are the foundation of Knowledge Building pedagogy (Scardamalia, 2002). The principles describe the key characteristics of effective knowledge creating organizations, framed in a way that is directly applicable to the classroom. You can also think of them as **12 habits of highly creative teams**. Rather than dictate step-by-step procedures for teachers and students to follow, the principles are a framework to help guide and evaluate practice. Creative work with knowledge is a complex process, and so the principles represent flexible ideals that will manifest themselves in a great variety of ways in many different contexts. Indeed, in every highly creative team — be it a Nobel laureate lab, an innovative business, a team of designers, or a KB classroom — you will find these principles operating in one form or another.

| | | |
|---|---|---|
|  <p>Real Ideas, Authentic Problems Knowledge problems arise from efforts to understand the world. Ideas produced are as real as things touched and felt. Problems are the ones learners care about — usually very different from textbook problems and puzzles.</p> |  <p>Improvable Ideas All ideas are treated as improvable. Students work continuously to improve the quality, coherence and utility of ideas. This requires a culture of psychological safety so that people feel safe taking risks — revealing ignorance, voicing half-baked notions, giving and receiving criticism.</p> |  <p>Idea Diversity Just as biodiversity is crucial to the success of an ecosystem, so is idea diversity to knowledge advancement. To understand an idea is to understand the ideas that surround it — including those that stand in contrast to it.</p> |
|  <p>Epistemic Agency Students take responsibility for their ideas by determining the learning outcomes, processes, and the accompanying challenges. Students engage in negotiation and dialogue to fit personal ideas with others.</p> |  <p>Democratizing Knowledge The creation of knowledge is not confined to a few. Instead, all are empowered to create and are recognized as valid contributors to advance community knowledge.</p> |  <p>Pervasive Knowledge Building Knowledge Building is not confined to particular occasions or subjects but pervades mental life.</p> |
|  <p>Rise Above Creative Knowledge Building entails working towards higher-level forms of problems. It means learning to work with diversity, complexity, and messiness. By moving to higher planes of understanding, Knowledge Builders transcend oversimplifications.</p> |  <p>Symmetric Knowledge Advance Expertise is distributed within and between communities; community members understand that <i>"to give knowledge is to get knowledge."</i></p> |  <p>Knowledge Building Discourse The power is in the discourse — in collaborative interchanges that lead to better solutions, better explanations, and better ways forward.</p> |
|  <p>Embedded, Concurrent & Transformative Assessment Assessment is part of the effort to advance knowledge — it is used to identify problems as the work proceeds and is embedded in the daily workings of the organization. The community engages in its own internal assessment, which is more fine-tuned and rigorous than external assessment, and serves to ensure that the community's work will exceed the expectation of external assessors.</p> |  <p>Constructive Use of Authoritative Sources To know a discipline is to be in touch with the present state and growing edge of knowledge in the field. This requires respect and understanding of authoritative sources, combined with a critical stance toward them.</p> |  <p>Community Knowledge, Collective Responsibility Contributions to shared, top-level goals of the organization are prized and rewarded as much as individual achievements. Team members produce ideas of value to others and share responsibility for the overall advancement of knowledge in the community.</p> |

Images from Knowledge Building Community. Introduction to Knowledge Building. Retrieved from: www.kbsingapore.org/12-principles-of-kb/

THE 12 KNOWLEDGE BUILDING PRINCIPLES: INDICATORS AND “LISTEN FORS”

| KB Principle | What would I hear in the classroom that reflects this KB Principle? |
|--|--|
| Real Ideas, Authentic Problems | <p>“The real issue, I believe...”</p> <p>“What I’d REALLY like to know...”</p> <p>“Authentic from my point of view would be...”</p> |
| Improvable Ideas | <p>“Let’s design an experiment”</p> <p>“How does it work, REALLY?”</p> <p>“We used to think..., now we think...”</p> |
| Idea Diversity | <p>“I never realized there were so many ways to view this!”</p> <p>“That’s a new idea, I never thought of it that way”</p> <p>“Let’s try a different approach...”</p> |
| Epistemic Agency | <p>“I think we should take this in a different direction altogether,”</p> <p>“How does this address our problem? What’s our goal here?”</p> <p>“Let’s plan next steps now, so we can stay on course”</p> |
| Democratizing Knowledge | <p>“What can we do to get everyone involved?”</p> <p>“We seem to have lost the interest of several people”</p> <p>“Interesting idea — how can we help?”</p> |
| Pervasive Knowledge Building | <p>“In a movie I saw this cool demonstration — it worked like this”</p> <p>“I took a picture so I’ll remember”</p> <p>“I thought of this while I was walking in the park on the weekend”</p> |
| Rise Above | <p>“Let’s take this to a new level...”</p> <p>“How can we move beyond our current thinking?”</p> <p>“It can’t be that simple”</p> <p>“I bet we are missing something important here”</p> |
| Knowledge Building Discourse | <p>“This doesn’t explain how...”</p> <p>“We’re just grouping ideas together — what’s the big idea?”</p> <p>“That’s just a topic, what’s the real issue?”</p> |
| Symmetric Knowledge Advance | <p>“Another team discovered...”</p> <p>“What would those who disagree say?”</p> <p>“I’m willing to put this idea out there so others can help advance it”</p> |
| Embedded, Concurrent, & Transformative Assessment | <p>“Let’s look at our data and see how we’re doing”</p> <p>“We seem to be stuck. How much progress have we made?”</p> <p>“Good we caught this mistake early”</p> <p>“Our best insight so far...”</p> <p>“The idea that really needs work...”</p> |
| Constructive Use of Authoritative Sources | <p>“How would someone with more knowledge handle this?”</p> <p>“There seems to be agreement among experts that...”</p> <p>“How does this expert’s idea fit with ours?”</p> <p>“Here’s what someone who knows a lot says”</p> |
| Community Knowledge, Collective Responsibility | <p>“Our ideas don’t fit together”</p> <p>“We need everyone’s ideas on this”</p> <p>“How would you describe our current state of understanding?”</p> <p>“We’re all saying the same thing!”</p> |

THE 12 KNOWLEDGE BUILDING PRINCIPLES: SOME GUIDING REFLECTION QUESTIONS

| KB Principle | Some Guiding Reflection Questions |
|--|---|
| Real Ideas, Authentic Problems | <ul style="list-style-type: none"> • Is this a problem that's truly authentic & interesting to students? • What opportunities and activities can I design that can help bring out students natural curiosity and interest? |
| Improvable Ideas | <ul style="list-style-type: none"> • How can I start to build a culture of idea improvement with my students? (e.g., one of safety, equitable participation, critical friends, idea diversity, etc.) • How can I help students see the trajectory and development of their own ideas and their own learning? |
| Idea Diversity | <ul style="list-style-type: none"> • How can I support expression of idea diversity from students? • How can I display and make visible students' range of ideas? |
| Epistemic Agency | <ul style="list-style-type: none"> • How am I already supporting student voice and choice in my practice? • What are some small steps I can take to hand more and more agency over to students? What would represent a big leap? • Do I see growth in my students' capacity for taking on more and more high-level responsibility? |
| Democratizing Knowledge | <ul style="list-style-type: none"> • How can the classroom setup help facilitate flow of knowledge between students? • Which practices/tools help to ensure exposure and access to everyone's ideas? • Do students feel overly possessive over ideas or advancements? • How can we as a community begin to value group achievements and free exchange of ideas? |
| Pervasive Knowledge Building | <ul style="list-style-type: none"> • Am I hearing evidence that students are thinking about their ideas and questions outside of the classroom? • Are they making unexpected connections between their KB work with other areas of their lives? • Are parents seeing the engagement and excitement at home? |
| Rise Above | <ul style="list-style-type: none"> • What evidence do I have that students are arriving at more sophisticated formulations of problems/deeper understandings? • How well do my students understand the idea of Rise Above as a driver for KB? |
| Knowledge Building Discourse | <ul style="list-style-type: none"> • Are we moving beyond idea-sharing to idea building? • Are students using the KB Scaffolds? (see pgs. 42-44) • Are students given enough time for group discourse? |
| Symmetric Knowledge Advance | <ul style="list-style-type: none"> • Am I seeing knowledge growth in every student? • Are all students benefiting from community efforts? • Are students showing an appreciation for the notion that exchanging ideas and sharing knowledge will benefit us all? |
| Embedded, Concurrent, & Transformative Assessment | <ul style="list-style-type: none"> • What assessment tools do I already use that lend themselves to KB work? • What can I use or adapt from this resource? • How can I get my students more involved in self and group assessment during the KB process? |
| Constructive Use of Authoritative Sources | <ul style="list-style-type: none"> • What do my students (still) have to learn and know about approaching a source critically? • Are my students using authoritative sources as evidence to support or discount their own ideas? |
| Community Knowledge, Collective Responsibility | <ul style="list-style-type: none"> • What can I/we do to get everyone engaged? • Do we understand the difference between individual and collective knowledge? • Do I get a sense that students are feeling responsible for contributing and building group knowledge, not just their own? |



“The KB Principles...convey the dynamics of these powerful communities that can advance knowledge for social good. So, they are components of a complex process, and the really good news is that any single one that you unlock helps to unlock the others. So it's not necessary to do 1, 2, 3, 4, 5, 6 ... any one of these that you start on opens the others for you. So why 12? There are components each one adds that is a bit different. Each one is a different facet — but, I would say focus on whichever one appeals to you.” — *Marlene Scardamalia*



**WHICH OF THE 12 KB PRINCIPLES RESONATE WITH YOU?
WHICH DO YOU ALREADY ENGAGE WITH IN YOUR PRACTICE?
WHICH REPRESENT NEW IDEAS?
HOW CAN YOU DEEPEN YOUR PRACTICE IN ACCORDANCE
WITH THE 12 KB PRINCIPLES?**

THE 12 KNOWLEDGE BUILDING PRINCIPLES: GROUP ACTIVITY



Try bringing the 12 KB Principles — or a smaller subset of the principles (say, 2 to 4) — to your students or to your colleagues in order to build a shared understanding as a community, and to help make the principles become classroom or school-wide norms. Below is one example of the kind of activity that you can do to introduce the KB Principles to your students or colleagues.

- Write each of the 12 principles on separate pieces of chart paper and hang them around the room or place them on tables (1-2 principles per table depending on what is available).
- At each table, include: i) a couple of markers; ii) a pack of sticky notes; iii) handout with description of the 12 principles (photocopy page 20 of this resource).
- Number students or colleagues off so that there are about 2-4 people per group. Assign each group a particular principle or set of principles.
- Each group reads the description(s) of the principle(s) they are assigned. Ask them to interpret the principle(s) (as students, as educators, etc.) and put it into their own words. Ask them to write a brief phrase or statement that summarizes their ideas.

FOR STUDENTS: Do a group share of the ideas generated. As a class, create a student-friendly version of the KB principles. Discussion questions could include: What would these KB Principles look and sound like in our class? When have we already seen this happening in our classroom? What are our next steps to make this happen in our class?”

FOR YOUNGER STUDENTS: Create an age-appropriate adaptation of the 12 principles, or a select sub-set of the principles. Bring these revised principles to the students and have a group discussion with students about their ideas and interpretations of the principles, and what they mean to the classroom community.

FOR COLLEAGUES: Participants think about the principle that resonates with them the most, and move to that principle. Next, ask them what that principle might look, feel and sound like in the classroom. What strategies and activities do they already practise that reflect this principle? Participants share their ideas on sticky notes and chart paper. Encourage thoughts on the question: *Are there ways to build upon or deepen these practices that are in alignment with the KB principles?* Write ideas on stickies and add to the chart paper. Share as a group.

- Participants think about the principle they still need to understand. They write questions and wonderings on sticky notes and place them on the chart paper. Share as a group.
- Revisit this activity once colleagues have had time to work with this resource and put some ideas into practice to see how thoughts and understandings about the principles have grown.

THE 12 KB PRINCIPLES AND INDICATORS

On the next page, the 12 Knowledge Building Principles are listed in the left column. The middle and right columns articulate two ends of a spectrum of practices corresponding to each principle. The right hand column indicates evidence of deep Knowledge Building practice.

| KB Principle | Common Standards | Knowledge Building Value Added |
|---|---|--|
| Community Knowledge, Collective Responsibility | Participants collaborate on the production of a finished product that demonstrates individual or small-group learning. | Participants take responsibility for the overall advancement of knowledge in the community. |
| Constructive Uses of Authoritative Sources | Participants critically evaluate information sources and recognize that even the best are fallible. | Participants use authoritative sources, along with other information sources, as data for their own Knowledge Building and idea-improving processes. |
| Embedded, and Transformative Assessment | Externally defined assessment is taken seriously but does not dominate knowledge work. | The community engages in its own internal assessment, which is both more fine-tuned and rigorous than external assessment, and serves to ensure that the community's work will exceed the expectations of external assessors. |
| Democratizing Knowledge | Everyone's work is recognized and praised; participants help each other find needed information. | All participants are legitimate contributors to the shared goals; all have a sense of ownership of knowledge advances achieved by the group. |
| Epistemic Agency | Participants demonstrate a personal sense of direction, power, motivation, and responsibility. | Participants mobilize personal strengths to set forth their ideas and to negotiate a fit between personal ideas and ideas of others, using contrasts to spark and sustain knowledge advancement rather than depending on others to chart that course for them. |
| Idea Diversity | Different ideas or opinions are brainstormed, and then grouped into categories, and finally arguments are carried out to resolve differences. | Different ideas create a dynamic environment in which contrasts, competition, and complementarity of ideas is evident, creating a rich environment for ideas to evolve into new and more refined forms. |
| Improvable Ideas | Ideas are accepted or rejected on the basis of logical argument and evidence. | All ideas are treated as improvable; participants aim to mirror the work of great thinkers in gathering and weighing evidence, and ensuring that explanations cohere with all available evidence. |
| Pervasive Knowledge Building | Special time is set aside for creative work with ideas after basic work is done; special technologies and supports encourage creative work. | Creative work with ideas is integral to all knowledge work. |
| Real Ideas, Authentic Problems | Project-based learning replaces short-term tasks with more complex, ill-defined tasks. | Real knowledge problems arise from efforts to understand the world; creative work with ideas supports faster and more reliable learning, whereas learning alone seldom leads to knowledge innovation. |
| Rise Above | Teacher or leader takes responsibility for synthesizing diverse ideas, identifying common ground, and presenting new challenges. | The conditions to which people adapt change as a result of the successes of other people in the environment. Adapting means adapting to a progressive set of conditions that keeps raising standards. |
| Knowledge Building Discourse | Discourse allows participants to express and gain feedback on their ideas, defend different points of view, arrive at conclusions. | Discourse serves to identify shared problems and gaps in understanding and to advance understanding beyond the level of the most knowledgeable individual. |
| Symmetric Knowledge Advancement | Groups carry out inquiries independently and then publicize their findings for the benefit and response of other groups. | Interleaved communities provide successively more demanding contexts for knowledge work, and set into motion inner/outer community dynamics that serve to embed ideas in a broader social context. |

Scardamalia, M. (2003). Knowledge building principles and indicators.
Retrieved from <http://ikit.org/SummerInstitute2003/posters/kbindicators.html>

WHY KB CAN REACH EACH AND EVERY LEARNER

Complementary to the 12 principles, there is some exciting new research that helps describe specific qualities that characterize especially innovative organizations and teams of people working in any domain — say, for example, the most successful and creative design teams at Google (see Gloor & Fronzetti, 2015; Pentland, 2014). Fascinatingly, many of these qualities revolve around the *way groups work together* rather than the *individual expertise that each person brings to the table*. As this research tells us, three of the most powerful qualities that describe the way creative and innovative groups work together are:

1. THEY NURTURE A CULTURE OF PSYCHOLOGICAL SAFETY
2. THEY ARE 'BRAVE AND KIND' WITH ONE ANOTHER
3. MEMBERS ENSURE THAT EVERYONE CONTRIBUTES EQUALLY IN CONVERSATION

This research is exciting because it reinforces the fundamental KB tenet that in any KB community, **every single member is a valid and critical contributor**. A diversity of skills, ability levels, talents and interests can be supported through collective efforts to improve ideas and puzzle through authentic problems, and can result in high levels of creativity, innovative capacity, and success for all — given these important group dynamics and conditions are present.



“When we have asked students to compare Knowledge Building with other school experiences, they speak about the pleasure of working together, finding new information that helps advance an idea, seeing their theory taken up by someone else, discovering that the more you know, the more you know what you don’t know, understanding that learning is not so much a matter of the right answer as putting the pieces together in a way that makes sense, and viewing the knowledge advances they have made as team successes” (Bereiter & Scardamalia, 2014, p. 46).



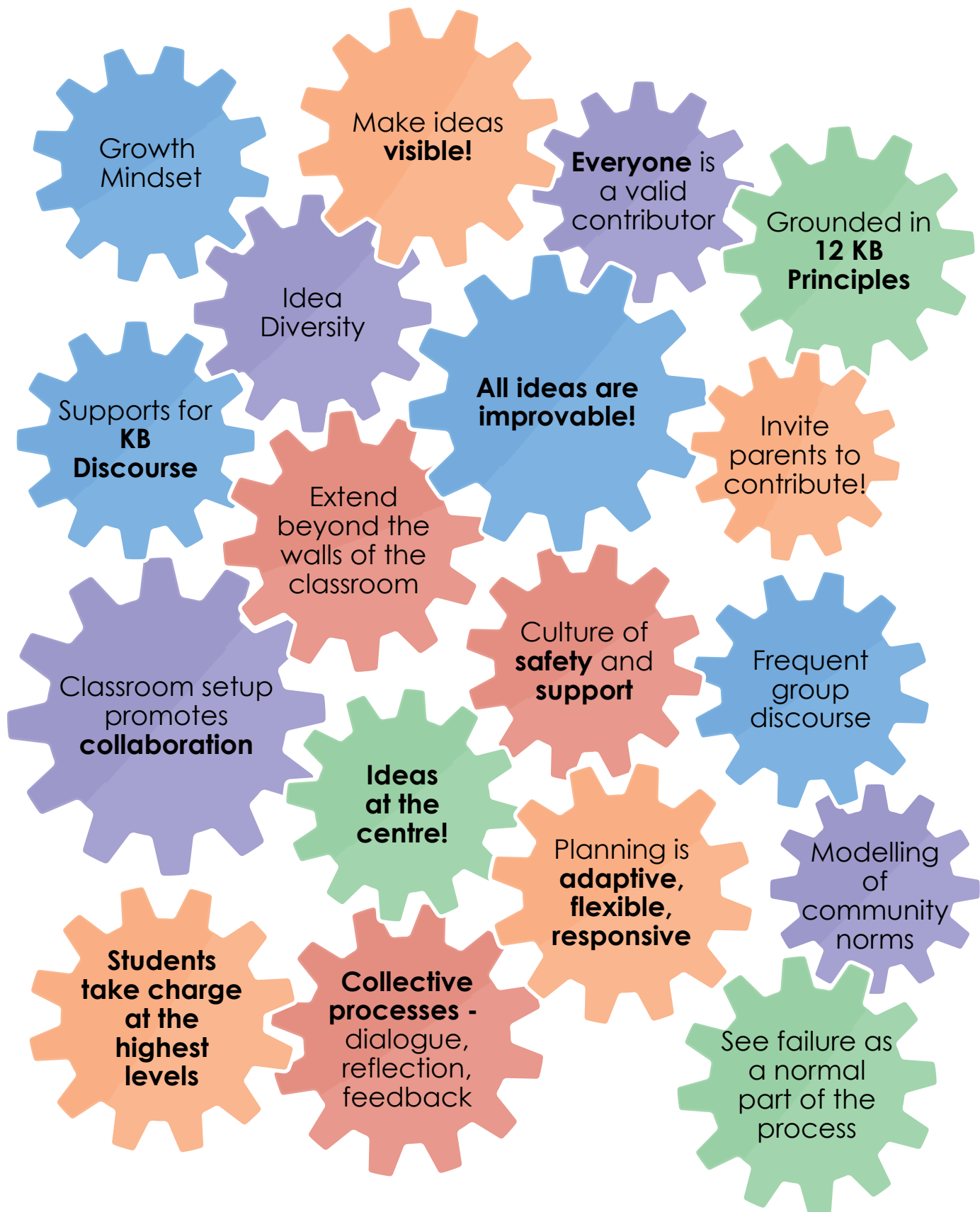
WHAT DOES A KB COMMUNITY LOOK LIKE IN THE CLASSROOM?

The qualities that describe highly effective, innovative groups that operate out in the world are the same that are fostered through meaningful participation in a KB community. For example, a culture of safety and respect is critical. Students must understand import modes of behaviour:

| | |
|-------------------------------------|--------------------------------------|
| Respectful listening | Paraphrasing to ensure understanding |
| Making eye contact while conversing | Asking questions for clarification |
| Waiting turns to talk | Accepting diverse ideas |

The qualities highlighted in the image on the following page are elements of classroom life and culture that KB teachers have identified as important to make explicit and focus on in the effort of growing an effective KB community in a classroom. Finding ways to effectively engage these traits and explore how to put these ideas into action in ways that make sense for you and your students can help bring the 12 principles to life and translate them from theoretical ideas to effective practice, strategies, and tactics.

THE MOST IMPORTANT ELEMENTS OF A KB CLASSROOM



THE TEACHER'S ROLE IN A KB CLASSROOM

Idea improvement, innovation, and creative problem solving aren't linear or fixed processes. Often, they are messy, challenging, and unpredictable. However, their organic and emergent nature does not mean they are uncontrollable or chaotic — they still need to be guided by goals and objectives, and demand the right kinds of conditions to thrive.

The key element needed for a KB community to grow is a teacher who believes in the process, is dedicated to nurturing it in their classroom, and who has faith that their students can take on the challenge.



“It's not easy! One of the hardest things is not to “rescue” the kids but to let them problem solve, work through puzzlement, and come to the ideas and solutions themselves. Try prompting them to dig deeper rather than giving them the answer or labeling an idea as right or wrong” — *Grade 1 KB teacher*



While Knowledge Building is goal-directed, the path to that goal is unknown and must be discovered by the students themselves — KB teachers support their students in this process. KB requires the gradual transfer of epistemic agency and high-level responsibilities over to students. Epistemic literally means “related to knowledge or knowing” – therefore, the principle of epistemic agency calls for students to have power over how they come to build knowledge and chart the course of their own learning. What this means is that, in a KB community, duties that were traditionally reserved only for the teacher, such as creating and setting knowledge goals, identifying setbacks and challenges, assessing knowledge progress, revising questions and strategies, ensuring equality of opportunity, and so on, need to be handed over to the students as much as possible (Bereiter & Scardamalia, 2014, p. 39). Marlene Scardamalia likes to say, **“hand over as much agency to your students as you possibly can, then hand over some more!”** In this way, students acquire leadership skills, confidence, and the ability to persevere through challenges. KB research from around the world shows that students from diverse backgrounds and achievement levels exceed expectations time and again when teachers take the leap of faith and hand more and more agency over to the kids (Scardamalia & Egnatoff, 2010). The Teacher Talk prompts support teachers in this effort.

KB TEACHER TALK

Can you tell me more about your idea?

Have you considered other people's ideas?

How do you/we know that?

How could you/we find out more?

What could you/we do next?

What do you/we notice?

What is our best understanding so far?

Why don't we bring that question to the group or next KB circle?

What do you/we think might happen if?

Why do you/we think that happens?

How do you/we think that happens?

What might you/we be stuck on?

What can you/we do to help get “unstuck”?

What do we still need to understand?

It is critical to note that KB teachers are not simply “letting go.” On the contrary, teachers are deeply immersed in community work — monitoring, assessing, supporting, modeling, designing, planning, and teaching “just in time.” **Teachers help to ensure the classroom conditions allow for knowledge to grow and emerge organically.** They respond to student needs and nurture students’ idea growth by prompting them to dig deeper, elaborate on their ideas, consider problem areas they may have overlooked, think about useful next steps, and so on. The teacher also must be responsive to the community’s ideas, misconceptions, and knowledge gaps, designing mini-lessons or experiments “just in time” that will help students move their thinking forward. Likewise, the teacher also models a “KB stance” to students — this includes not being afraid to say “I don’t know the answer!” or “I made a mistake!” An overview of the key characteristics of a KB teacher is summarized below (adapted from *Natural Curiosity*, 2011, pg. 18).

“This is one of the things that Knowledge Building teachers do that is so understated. It’s not ‘guide-on-the-side’, it’s not facilitation, it’s finding and cultivating the sparks, it’s literally believing you will, as a community, come up with something new, and you have the wherewithal to do that”
— *Marlene Scardamalia*

- Makes establishing a culture of psychological safety a priority
- Is a co-learner with the students
- Truly believes that all students are able to contribute to and benefit from the process
- Watches for teachable moments arising from student conversations (online, face-to-face)
- Focuses on Big Ideas/major expectations/key concepts rather than specific expectations
- Guides students’ access to resources, people, experiences, etc., to help them with their work
- Plans mini-lessons when needed to address misconceptions or knowledge gaps
- Records and reflects on students’ contributions, questions, ideas, etc.
- Provides students with opportunities to express and develop ideas in multiple modes
- Gives opportunities for frequent KB Discourse
- Models inquiry-based thinking processes
- Encourages students to work in “design mode” to help them to learn how to explore ideas
- Is adaptive, responsive, plans in a flexible way
- Designs experiences (discussion, experiments, field trips) to expose students to new ideas and to help students dig deeper into their ideas

KEY ELEMENT: If a safe and respectful learning environment doesn’t exist in the classroom, then it will be a great challenge to develop a thriving KB community.

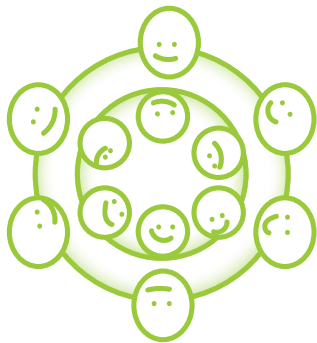
“It’s like going on a trip with your family. I have a family of kids here. And I can say to them, “we’re taking a holiday and we’re going here and this is what bus we’re going on and this is how we’re going to get there and this is the route and all that stuff. And yes, some of the kids might love to do that. But the way we have it now where they choose — I think of it this way. They’re choosing the destination that they go for the holiday, they choose what mode of transport we’re going to use to get there. They choose what stops we’re going to make along the way, where we go for burgers or fries, where we stop for the bathroom. Maybe they see something on the side that’s interesting and they want to switch, and we never get to that original destination. But I think if you presented that to kids and said, “where do you want to go on holiday, and you have carte blanche,” will they be engaged and will they want to plan it out? Absolutely. And I see that analogy as how we’re doing this inquiry. And at the end of the day, they’re still learning how to plan, and book the hotel, and research the destination, and ultimately enjoy the destination. But it’s their choice, not mine, and I’m just there to make sure they don’t get lost”
— *James Lim, Intermediate teacher.*

COLLABORATING AS A KB COMMUNITY: STRATEGIES FOR THE CLASSROOM

The activities and techniques described on the following pages were used by Elaine Heaver, former KB teacher and Inquiry Coach for the HWDSB. These activities can be used from the onset of the school year to help build the kinds of collaborative culture and community dynamics that are needed for Knowledge Building work to thrive. The more students get comfortable sharing and building on one another's ideas, the more they interact as kind and respectful risk-takers. And the more they get accustomed to working as a team, the healthier the KB community will be, and the greater the student achievement.

INSIDE-OUTSIDE CIRCLE

An outer student circle faces an inner student circle. After the student pair facing each other shares/reflects/discusses, the outer circle rotates to make new pairings. After several rotations, the whole class can discuss connections, ideas that surfaced frequently, contradictions, etc.



STANCE LINE

Students form a single line based on how they feel about an issue (e.g., one end of the line represents 'strongly agree' and the other end is 'strongly disagree'). After determining where on the line they stand, have the first half of the line walk down the line so they are facing the second half of the line. Students defend/discuss their stance with the person they are now facing.

THOUGHT TUNNEL

Students stand in one of two lines facing each other. Each line represents an opposing point of view about an issue. Students who are

undecided or "fence sitting" take turns (one at a time) slowly walking through the space between the two lines. As the walker moves forward, the students in the line give reasons why their side (point of view) is correct. Once the walker has reached the end of the line, he/she decides which side to join and identifies which point(s) affected his/her decision. (*Idea:* the students in line only speak when the walker is within arm's reach to avoid too many students talking over top of one another).

MOCK NEWSCAST

Behind a table or standing with a microphone 'on location,' students share their findings like a breaking news story. Groups can share as a news 'team' (e.g. a news reporter interviewing an expert in the field for a documentary).

MAPS

Students make a map to reflect their findings (e.g., showing human migration, locating an event or species, representing populations). Students can create their maps individually, collaboratively in small groups, or create a whole class map in order to make connections, find patterns, or get the 'big picture.'

TIMELINE

Students place events on a timeline to see where they fit in, and how they are connected

to or influenced by other events. Timelines can be created individually, collaboratively in small groups, or as one whole-class timeline. Discuss, compare, and reflect on the timeline(s) to find patterns, trends, relationships, causes, and consequences.

OOH-AAH METER

5 students stand at the front to share a 'cool fact' about their topics. The seated students react to each fact — e.g. "Ooh" or "Aah." The student who receives the most enthusiastic response stays standing and is joined by four new students. The process is repeated, with the goal being to stay up front as long as possible. (*Advantage:* Students are motivated to dig deeper for interesting facts) (*Option:* Students can get another try at the front if they can make a solid connection between seemingly unrelated facts shared by two separate students).

HOT SEAT

An individual (or a small group of students) enters the room in character (e.g., expert in the field, stakeholder of an issue, historical or contemporary person). He/she sits in a chair facing the class. The class asks questions to learn about the 'visitor's' experiences, thoughts, expertise...

TABLEAU

A group of students form a tableau to convey their understanding about their topic. A student from the 'audience' approaches the tableau and taps one student from the tableau on the shoulder. This tap on the shoulder 'brings the character to life.' The student from the audience asks the character questions to learn who/what they are, what they are doing, why they are doing it, etc. That character then rejoins the tableau. Students in the audience take turns 'bringing characters to life' and asking questions. Together, the audience tries to make inferences, find out if their inferences

are correct, and piece the information gathered together to get a 'big picture' of the situation being represented by the tableau.

GRAFFITI

Provide mural paper, butcher paper, or chart paper and coloured markers around the room. Place a question, topic, statement, or picture in the centre of each large paper. Silently, students treat the blank space as a 'graffiti wall' where they show their thoughts/ideas/understanding through pictures, words, phrases, symbols, etc. Students can stay at one paper that is related to their own focus, or students can move around the room to different papers and add contributions to some or all of the graffiti walls. When finished, the class views the completed graffiti walls like a gallery and offers reflections, observations, asks questions, etc.

ARTISTIC REPRESENTATION

Students represent their knowledge in an artistic or graphic form (e.g., sketches, labelled diagrams, webs, collages). Students display their artistic representation around the room. (gallery style) viewing the different works. *Options:* Artists briefly summarize their work. Each stands by their work as students have a Q&A time (e.g. Can you tell me more about your...? Is it significant that you mostly used the colour red?). Students find similarities in their work and another student's work and discuss the significance.

CAUSAL MODEL

In the centre of a large piece of paper, write an event, situation, or fact (e.g., There are only three Northern White Rhinos known to be left on earth). Students determine various causes of the event (e.g., People hunted rhinos for sport; poachers collect rhino horns, etc.) Each cause is recorded around the event with an arrow from the cause to the event (to show the causal relationship). Students then determine causes

for each of the causes (again, with an arrow from the cause pointing to the effect). Students keep working to determine the cause of each new thing they record. (Sometimes, a cause might link to more than one other causal factor). When students reach the end of a “branch,” this helps determine where their knowledge ends and indicates where they could dig deeper. Identifying causes of problems helps students determine solutions to problems.

FISHBOWL

The class forms a large circle. A small group of students sit in the middle of the circle (inside the ‘fishbowl’).

To share information:

The small group in the middle discusses or debates the topic, issue, or event that they have been researching. The students in the outside circle listen to the discussion and record key points. When the small group’s discussion or debate is complete, the outside circle reflects on what they heard/learned and its implications. At this point, the outer circle may ask questions of the small group to clarify or gain more information. Students in the fishbowl may receive feedback from the outer circle on things like their understanding of the topic, and their ability to support their comments (with facts, valid reasoning, expert sources, etc.).

To target students’ collaborative discourse skills:

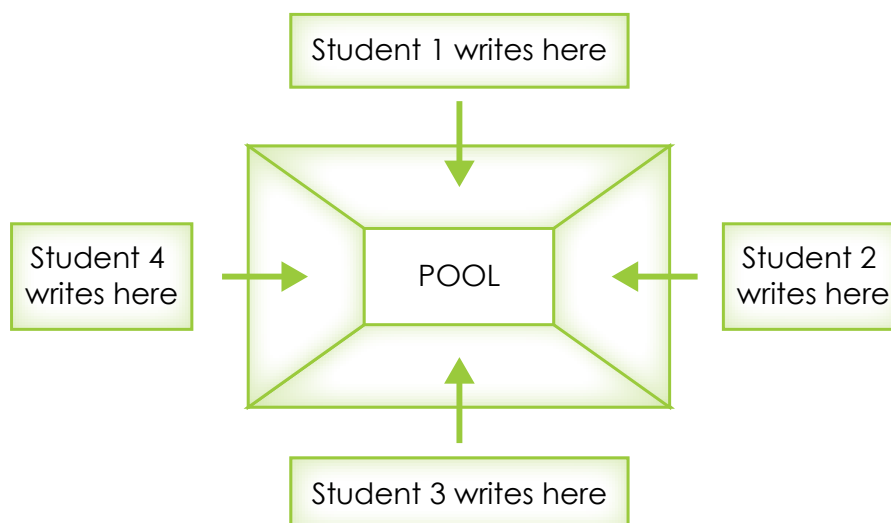
The small group in the middle debates or discusses an issue. The students in the outside circle listen to the discussion and record their observations related to how the students in the fishbowl demonstrate identified skills, such as:

- Acknowledging others’ ideas
- Respectfully disagreeing
- Asking questions to clarify or extend
- Thinking

When the small group’s discussion/debate is done, the students in the fishbowl receive feedback from the outer circle on the collaborative discourse skills they demonstrated.

PLACEMAT

Students independently and silently write their thoughts/ideas/new learnings in their own section of the placement. Then, in the same groups of 4, students share and discuss what is written in each of the four sections. The middle “pool” section is for the group to record connections they make, patterns they see, big ideas, etc. As a whole class, the middle “pool” from each group can be compared and discussed.



GETTING STARTED WITH KNOWLEDGE BUILDING

GETTING STARTED: ENGAGING REAL IDEAS, AUTHENTIC PROBLEMS



THE THEORY:

Knowledge Building is grounded in problems of understanding that are truly **meaningful and authentic to the community itself**. A sense of ownership and agency over one's work, as well as being deeply engaged in a matter that one is truly interested in or passionate about, does wonders for people's sense of **well-being, motivation and self-worth**. It is also vital to productivity and success in knowledge work. This is true as much for adults in the workplace as it is for students in the classroom. When students are given the opportunity to pursue issues and problems that really matter to them, students' sense of autonomy and agency skyrockets.

Asking deep and rich questions that can spark and sustain a prolonged KB inquiry is a critical part of creative knowledge work. Students, especially those in younger grades, are often full of questions about the world around them. Sometimes, however, inspiring students to pose meaningful questions may be a challenge. The importance of giving students opportunities to really engage with real-life issues, phenomena and problems when it comes

to Knowledge Building cannot be overstated. Cultivating a classroom environment where questioning and wonderment are valued is equally important. The stronger a culture of questioning, and the more authentic and real the "hook," the more likely students will start out of the gate guided by rich and interesting questions that really matter to them.

“The real world coming into the classroom really gets to be the hook that gets them thinking about what matters, as opposed to necessarily questions that might be generated by the teacher. These are the questions that become generated by the students, and what they have been wondering about”
— Glenn Wagner, Secondary KB teacher.

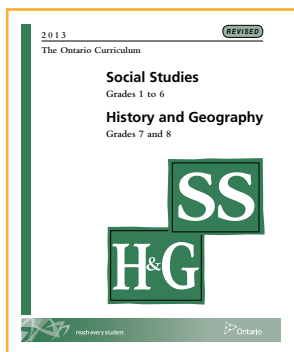
PROVOCATIONS AND HOOKS TO IGNITE KNOWLEDGE BUILDING

THE PRACTICE:

Provocations that can spark and harness students' natural curiosity are most successful when the classroom culture supports deep thinking, effective collaboration and creative work with ideas. However, a healthy community culture doesn't necessarily precede effective "hook" opportunities or activities, though it can make kicking off KB work easier. Typically, and especially at the onset of the year, exciting provocation activities and community-building experiences can enrich one another, helping to create a dynamic and supportive KB community.

Experiences that spark students' interest and elicit genuine "I wonders" can set a course for authentic and sustained Knowledge Building. Indeed, it is crucial that Knowledge Building work stems from **real ideas, and authentic problems**. At the same time, it is necessary for students

to be deeply engaged in the curriculum as they work. **However, rather than representing a dilemma, these two criteria are complementary to one another.** When students get hooked on a problem of understanding that is real to them, they can't help but engage with the curriculum in deep and meaningful ways.



For many KB teachers, their first step in the beginnings of a KB journey is the curriculum document. The Big Ideas or major expectations outlined in the curriculum are a great point of departure for a KB study.

IN YOUR EXPERIENCE, WHAT AREAS OF THE CURRICULUM TEND TO INCITE STUDENT INTEREST AND ENGAGEMENT? WHAT AREAS OF STUDY EXCITE YOU AS A TEACHER?

Once a general theme/subject area is selected, think about creative strategies that can foster students' natural curiosity and motivation. As inspiration, some tactics are suggested below!

TRIED AND TESTED KB "HOOKS"

On the following pages you'll find examples of effective KB hooks, as well as a list of resources, to inspire and ignite ideas that can work in your own classroom.



- **Watch clips and videos that stimulate students' curiosity, questioning, and ideas.** Explore how Glenn Wagner uses [AsapSCIENCE](#) to engage his students in asking promising questions about astronomy. [Click here](#) to watch a video case study series on Glenn's classroom, or visit <http://thelearningexchange.ca/projects/knowledge-building/?pcat=999&sess=4>
- **Take your students outside to observe phenomena in your local community.** Check out Cindy Halewood's "20-minute field trips." Get your students outside and observing phenomena right in their own community. Give them Nature Notebooks to record observations, questions, and ideas. [Click here](#) or visit http://www.naturalcuriosity.ca/pdf/Twenty_Minute_Field_Trips.pdf
- **Engage in interactive read-alouds.**
- **Explore the curriculum together.** Jason Frenza introduces the curriculum to his students right off the bat, allowing them to choose which aspects they are interested in. Based on the Big Ideas found in the curriculum, the class community then co-creates knowledge goals that help to guide their KB study as it unfolds. (See pg. 138 for a classroom example of co-created knowledge goals, or [click here](#) to watch a video series of Jason's class. <http://thelearningexchange.ca/projects/knowledge-building/?pcat=1102&sess=9>
- **Do experiments!** Conduct an experiment where students can make hypotheses and test their ideas, like this water experiment that had students witness a seeming miracle overnight! (See Exploring Cycles using Knowledge Building and Knowledge Forum in Grade 1 in the KB Case Studies package available via [The Learning Exchange](#) at [Knowledge Building Gallery / Leading Student Achievement: Networks for Learning](http://thelearningexchange.ca/wp-</div><div data-bbox=)

- **Pay attention to questions or observations that arise spontaneously** and bring these back to the class for further inquiry and exploration. Watch how one spontaneous question about a classroom mobile ignited a Senior Kindergarten class to explore the idea of gravity! ([Click here](#) to watch this class in action or visit <https://vimeo.com/45603301>).
- **Go on field trips.** Take students out into the community or on a virtual trip using Google Expeditions! <https://www.google.ca/edu/expeditions/>
- **Invite students to bring in artifacts** from their home or local community as objects of inquiry.
- **Bring in an expert or community member.** Angela Hoffman and Mubina Panju brought in parents to talk about their jobs and inspire their students to explore the question: What makes a community? (See the case study KB in Primary: What Makes a Community? in the KB Case Studies package available via [The Learning Exchange](#) at http://thelearningexchange.ca/wp-content/uploads/2017/04/2_2-Exploring-Electricity_Accessible.pdf
- **Welcome classroom pets.** Bev Caswell and her Grade 6 students explored concepts ranging from evolution to classical conditioning with their beloved classroom pets — Madagascar hissing cockroaches! Watch this incredible story [here](#) or visit <http://thelearningexchange.ca/projects/knowledge-building/?pcat=999&sess=7>
- **Engage primary sources** as objects of inquiry. In the following section are some ideas and resources for acquiring interesting and diverse primary sources.

SELECTING RESOURCES TO SUPPORT KB PROVOCATIONS AND STUDENT WONDERING

ARTWORKS

- National Gallery of Canada

MAPS

- Google Earth
- Google Streetview, GPS

VIRTUAL GUESTS / CONNECT WITH EXPERTS

- Skype
- Human Digital Library
- Partners in Research
- Nepris.com –STEM/STEAMs fields
- Skype in the Classroom Virtual Researchers on Call (VROC)

VIDEO SERIES

- ASAP Science Ted Talks (0-6,12,18, 18+ mins)
- VIRTUAL MUSEUM EXHIBITS The Virtual Museum of Canada

DATABASES

- Library and Archives Canada
- StatsCan
- NEWS ARCHIVES
- CBC archives

HISTORICAL THINKING WEBSITES

- Historical Thinking Matters
- Great Mysteries in Canadian History
- Historica Canada

NATURE WEBCAMS

- [Explore.org](#) — watch one of several “Bear Cams” set up in Katmai National Park
- [Canadian Peregrine Foundation](#) — 7 webcams are live filming peregrines nests in the GTA. (www.peregrine-foundation.ca/)
- [Earthcam.com](#) — tune in to anything from what’s happening in NYC’s Times Square to a live feed of an osprey’s nest in Massachusetts, where a pair of new parents are raising their offspring.

INSPIRING PROMISING QUESTIONS AND IDEAS



Sustained Knowledge Building work relies upon continual questioning and idea development. If students are not pursuing deep and meaningful questions or problems, they are likely to struggle during the process. Helping students become great questioners is one of the key roles of a KB teacher. Sometimes, rich questions can emerge quite easily — students who are used to working in a culture where questioning is welcomed may be more expressive and willing to pose wonderings and queries. Likewise, stimulating and authentic provocation opportunities and experiences can inspire rich questioning. Tools and activities like the **Hot Seat, Fishbowl**, and others (see pgs. 31-33 and 39) can help give students practice posing questions to a group, and

provide them with a helpful framework for thinking about using questions as a tool for inquiry. In Knowledge Building, exploring questions is more than just seeking out “the answer.” In the process of creative idea development, one question leads to another question leads to another question, ad infinitum. Sometimes, great questions come immediately and spark an investigation, while at other times students might need to do a bit of work to land on a question or problem statement that really appeals to them, and that has the potential to sustain a deep and prolonged inquiry. For example, students may need time to open up smaller, more specific questions to encompass a wider scope and problem space. On the other hand, they may need to figure out how to narrow their wonderings down to more focused questions that are feasible for them to explore. **This process of question refinement, or reframing a problem, is just as much a part of creative knowledge work as anything else.**

Studies show even primary and junior level students can make meaningful ‘promisingness judgments’! (Chen, 2016)

A very important concept from a Knowledge Building perspective is the notion of *promisingness*. **A promising idea or question can be understood as “something that is considered worth spending time on.”** At some point or another, all creative experts have to assess what direction they ought to travel based on how promising they believe a certain path to be. While outcomes are never guaranteed, knowledge workers develop a habit of making these “promisingness judgments” and evaluating which ideas have the potential to be successful in order to make the most of available resources, energy, and time.

When it comes to the classroom, at the beginning of a KB study, there could be a plethora of ideas and questions that students could pursue. **What road will they choose to travel down? How far can their question or problem take them? Helping students think about whether their questions, problems, and ideas are “promising” is a very useful exercise to drive deep KB work.** There are a few practical examples of how to engage students in “promisingness judgments” (see pg. 57). On the following page we suggest tips for identifying and developing promising questions.

- Reflect on questions and ideas: *“Which of our questions and ideas seem to have the most evidence and support? Which do we think are worth spending the time to pursue?”*
- Review and reframe! A slight tweak of a question can change it from fact-based to promising — e.g., *“How old is the universe?”* becomes *“How do scientists know how old the universe is?”*; *“What are some reasons for the Cold War?”* becomes *“Why or did this particular event help spark the Cold War?”*

GAINING AND SUSTAINING MOMENTUM

GAINING MOMENTUM: KNOWLEDGE BUILDING DISCOURSE

THE THEORY:

Providing students repeated opportunities to engage in peer-to-peer Knowledge Building Discourse is one of the most important practices in Knowledge Building. KB Discourse provides the habitat for collective knowledge — it is the place where ideas emerge, mix, mingle, and grow. KB Discourse moves beyond the sharing of information towards actively developing theories, building upon ideas, and creating new knowledge.

“KB” Discourse — also referred to as “discourse in *design mode*” — plays a very creative and critical role in Knowledge Building work. Research tells us that a key to great classroom discussion includes students taking on **diverse contributor roles** (de Bono, 1985; Hogan, 1999; Chuy et al. 2011). KB Discourse consists of dialogue moves such as: *theorizing, elaborating explanations, synthesizing, making analogies, reflecting, proposing design experiments, identifying promising ideas, questioning, searching for a better way*, etc. These discourse forms represent higher-level moves in knowledge work, and when engaged repeatedly, become forms of thought and habits of mind. Students are engaging KB Discourse when you hear them say things like “*I still don’t understand...*” “*I found information we should consider...*” “*How can you explain...?*” “*We need more information about...*” “*Let’s do an experiment to...*” These types of contributions all play an important role by helping to move shared knowledge forward. In Knowledge Building, it is important to remember that being able to argue whether something is right or wrong, true or not true, is not the ultimate goal. Instead, “*design mode*” discourse is concerned with the questions: **How can we make this better? Are we headed in a promising direction? Are we getting to the heart of the problem?**

““When you get KB discourse happening powerfully, the ideas keep going deeper and deeper. It’s not ‘The Answer’ but that idea leads to another idea leads to another idea...”
— Marlene Scardamalia”

““When we had a class debate, I was the one and only student who was not on a side because my theory was that light travels in waves, but the waves go in a straight line and the debate was between straight line and waves. And now we have lots of ideas from the debate and we don’t know which one is right. My theory now is light travels sort of like this: Light travels in a straight line but appears to be wavy or light travels in waves but appears to be straight. That means that light has aspects of both straight lines and waves. Evidence: It depends on how you look at it. Or what your experiment is trying to prove. In our class we have seen experiments that prove both that light travels in straight lines (box with powder and shadow experiments) and wavy lines (Thomas Young experiment).”
— Grade 4 Knowledge Builder contributes a “Rise Above” idea

For Knowledge Building to succeed, engaging in Knowledge Building Discourse needs to be a classroom norm. Knowledge Building discourse is not something that comes naturally or easily to people, let alone to young students (van Aalst, 2009). But there are simple and highly effective ways to get your students — no matter how young — to become fluent in this new language. The sections that follow turn towards some tools and practices that support **Knowledge Building Discourse** in your classroom, including **Knowledge Building Scaffolds, KB Circles, and Knowledge Forum.**

KNOWLEDGE BUILDING SCAFFOLDS

THE PRACTICE:

Get started with KB Discourse by introducing the Knowledge Building Scaffolds to students.

The KB Scaffolds represent the kind of talk that helps students actively develop theories, go beyond opinion and information-sharing to growing ideas and constructing new knowledge. The scaffolds represented below are typically referred to as the **KB Theory-Building Scaffolds**. These scaffolds represent very powerful “epistemic markers” — essentially, ways of thinking and knowing — that can help support student engagement in expert-like processes and behaviours, and help grow a culture of knowledge creation within a classroom. Post them around the classroom and encourage students to use these phrases during group discussions, such as KB Circles (see pg. 45). Soon they will become second nature.

I wonder...

I still need to understand...

My theory is...

Building onto this idea...

New information + source...

This theory does not explain...

Putting our knowledge together...

An improved idea...

We need evidence for...

We need an experiment to...

A promising idea...

Our next steps...

Another way of looking at it...

An example...

An analogy/comparison...



EXPANDING THE TOPIC: TALKING AND THINKING LIKE AN EXPERT

How can we support students in engaging in expert-like habits of mind and practice? What pedagogical inventions can support this effort? The **KB Scaffolds** are an example of a pedagogical innovation that are very effective in supporting students in thinking like an expert and engaging in high-level cognitive and creative knowledge processes. Below are a variety of scaffold examples inspired by KB research and related literature and teaching resources that explore how to help students think like an expert across domains (e.g., Denos & Case, 2006; Carey & Smith, 1993). The verbal stems represented in these scaffold sets are complementary to the KB Theory-Building Scaffolds on the previous page.

SCIENTIFIC THINKING

- My theory
- My hypothesis
- Evidence to support
- Evidence to disclaim
- Experimental evidence
- Experimental results
- Source of information
- We need evidence for
- Experimental design
- We're stuck
- My observations
- We need to find out
- Next steps

MATH

- Clarifying the problem
- What's difficult
- Another strategy is
- How to proceed
- An answer
- There's more to it
- I wonder
- In our own words
- A connection
- Another application

HISTORICAL THINKING

- Another perspective is
- This person/event/artifact is significant because
- Why we should care now
- A consequence of this event is
- A cause of this event is
- A motivating factor
- Important background information
- Evidence to support
- Evidence to disclaim
- What we need to find out
- A similarity between then and now
- A difference between then and now
- Next steps

Primary Grade Set THEORY BUILDING

- I wonder
- My theory
- New information + source
- Our improved idea

KNOWLEDGE BUILDING LEADERSHIP SCAFFOLDS

Educational leaders can nurture a Knowledge Building culture with colleagues and staff by using supports customized to professional learning. Below are some suggestions to get started:

I/we still need to understand...

My/our theory is...

Building onto this idea...

New information + source...

This theory does not explain...

Putting our knowledge together...

Here is my/our improved idea...

We need evidence for...

A promising idea...

Our next steps...

I am/we are going to investigate...

I/we encourage...

Are we headed in a promising direction?

How can we make this better?

Are we getting to the heart of the problem?

Another way of looking at it ...

An example...

An analogy/comparison...

My/our previous experience has...

led me/us to believe...

I/we now believe...

As a co-learner...

Co-designing with my team, I/we have discovered...

As an instructional leader...

As I/we try my/our new practice...

I am/we are frustrated by/surprised by...

I/we share your concern...



KNOWLEDGE BUILDING CIRCLES



THE THEORY:

Knowledge Building Circles (or KB Circles) are a very valuable part of a Knowledge Building classroom. They provide explicit time for students to engage in peer-to-peer discourse, build ideas, and develop community. The circle seating is intentional, and helps to promote the idea that everyone is equal and important to the Knowledge Building effort. KB Circles also help to promote successful Knowledge Building by giving students an opportunity to actively listen to the ideas of their peers, to communicate clearly and respectfully to others, to regulate behaviour, and to contribute their ideas to the rest of the community. In particular, Knowledge Building Circles not only reveal the skills and content knowledge that students accumulate, but also the manner in which they think about, interact with, and communicate their ideas (Natural Curiosity, 2011). It is often useful to develop criteria for behaviour that the group agrees upon prior to the first KB Circle. Teachers find issues will disappear as students discover their contributions and voices are valuable to the community.

THE PRACTICE:

KB Circles can take place as often as a community would like, but typically take place once or twice a week. KB Circles run for about 20-45 minutes, but may last longer. Sometimes you may wish to have whole-class KB Circles. Other times the class can be split up, with half of the students doing other activities and the remaining half participating in a KB Circle. Some teachers have students break out even further into simultaneous mini KB Circles consisting of 3-4 students each. This switches up the group dynamic and can help those shyer students to open up. It is also a great tactic to group students who tend not to participate and speak up together to encourage discussion and engagement. It is important, however, that the community comes together consistently as a full group to share insights and ideas as a whole community — a valuable and essential cultural norm to establish in a Knowledge Building classroom. It is critical that students are encouraged to use the KB Scaffolds to structure and focus their KB Circle conversations on idea building. The use of these thinking strategies helps distinguish KB Circle talk from any other small group conversation.

Watch a KB circle in action!

- Grade 1 from the Natural Curiosity Video series <https://vimeo.com/42169148>
- Grade 4 from the Natural Curiosity Video series <https://vimeo.com/58503126>
- Grade 5 from The Learning Exchange <https://vimeo.com/108100267>

The “Knowledge Builders” Podcast Series

A four-part series exploring innovation in a Grade 8 classroom. Listen for how the teacher uses KB Circles in his ideas-driven classroom! http://thelearningexchange.ca/projects_audio/knowledge-builders-podcast-series/

WHAT’S THE ROLE OF THE TEACHER IN A KB CIRCLE?

Initially, the teacher may be more of a central player in a KB Circle (especially with students new to KB and with younger students). **However, the goal is to have students engage in dialogue directly with one another as much as possible.** Some valuable teacher moves include:

- Re-introduce a student question that was promising but glossed over.
- Challenge students to try to expand their ways of contributing to group discussion by asking students to engage with new or different KB scaffolds.
- Try to encourage students to engage directly with one another if they are constantly looking to you as the teacher after every comment or to move things along.

EXPANDING THE TOPIC: EXCERPT OF GRADE 2 KB CIRCLE TALK

A Grade 2 KB class was studying birds as part of the Science curriculum stream. The exploration began with a series of short Nature Walks where students could observe the birds that were living in and around the schoolyard and make notes of their observations in their Nature Notebooks. These walks inspired the students' initial "I wonders" and KB questions. Concurrent to this open exploration of birds, students were also creating individual "All About" books. For these books, each student selected a bird to research and write about. This project provided a space for the teacher to embed a structured language activity within the KB inquiry, and gave students the opportunity to acquire special expertise around their bird of choice. One day while out on a Nature Walk, one of the children questioned how it was that among a flock of pigeons, only one was white, while all the rest were black. The teacher thought this was a great question and prompted the student to pose it to the rest of the class during the next KB Circle. The excerpt below details part of the KB Circle discussion that was initiated by this question, and offers a glimpse into a KB Circle talk at this Grade level. You'll notice that the teacher is highly present in this dialogue. This can be typical in primary Grades, as well as when students are new to KB Circles. In the latter case, as students gain experience, the teacher might speak much less, or not at all.

- Student A: They're different colours...some people think that every bird is not the same even though they're the same species, because they have different things that aren't in common...
- Teacher: So you're saying there are different kinds of birds within one species, so one species might look very different. And then, there are different kinds of birds...
- Student B: If there are different kinds of birds and they mate, that doesn't make a different kind of bird.
- Teacher: What makes a different bird?
- Student B: If just a different species mates a different species, like a hummingbird marries a pigeon...
- Teacher: And then what do you get?
- Student B: You get like a half hummingbird and a half pigeon.
- Teacher: Is it possible for a hummingbird and a pigeon...
- Student A: The baby would flap 100 times per second...

Student B: And they would be grey.

Student C: I'm adding onto [Student B's] idea, because I heard in this book that a zebra married a horse, and it was a horse with zebra stripes.

Student B: That is true there is one like that.

Teacher: So you're saying that this can also happen with birds, like it happens with horses and zebras. So species can intermix? So that might be why there are so many different kinds of birds?

Student B: So they can make new birds.

Teacher: So does that answer where do birds come from?

Student B: Ya, they come from one bird...it's...

Student C: I think that they might come from a different family, and maybe it's something like, um, they I don't really know, but like, I don't really know, but it might be like, an animal married another animal that becomes a bird, and then a bird, maybe, ya...

Teacher: So it changes over time? Does anyone know the big word for that?

Student B: Extinction?

Student D: Transformation?

Student B: I think I know why there's no more kinds of birds, because if they make a new bird, if two different species make a new bird, people would want to just hunt it because they didn't make a law to not kill those, and then it would go into extinction....like the Dodo!

In this example, the student who introduced the term “extinction” into the conversation had come across this word during his studies of the dodo bird, which was the species he chose for his “All About” book. There was no direct lesson about this idea beforehand. This is but one example of how the children contributed knowledge and ideas that they were gaining independently into the collective inquiry in meaningful ways. Now, while impressive, the use of the concept “extinction” still represents a misconception in this case, as do students’ ideas that species evolve due to species intermixing. **So how did the teacher handle this?** Since this discussion was close to the onset of the inquiry, she did not address this misconception right away, but allowed the students to keep exploring their ideas by doing research, engaging in KB Circles, and so on. However, if a misconception persisted too long, **the teacher would use the following strategies to address it: a) Read a book that targeted the concept(s) and have a group discussion about how the group’s ideas might have changed as a result of what they just learned; b) Give a direct mini-lesson on the concept to clarify understanding; c) Bring specific questions to the group during KB Circles that would inspire conversation around the issue.** In this case, after a set period of time, the teacher chose to highlight a question posed by another student during a subsequent KB Circle. This was actually a three-part set of questions that directly engaged ideas related to evolution, extinction, and adaptation. It was posted on Knowledge Forum as a note (Knowledge Forum is the online platform used to support Knowledge Building work. See pgs. 96-108 to explore how to use this technology.).

However, this note was not given much attention by students. The teacher intentionally re-introduced it into the KB Circle to encourage students to dig deeper with these sophisticated ideas:

- Teacher: So really, this is a three-part note. It looks like it includes: I need to understand where birds came from, that's one part, why there are so many different kinds of them, and what they are made of. What do you think of that?
- Student A: Evolution.
- Teacher: What does that mean?
- Student A: It means that birds were dinosaurs of a different kind, and then they "evoluted," or um, or, like us.
- Student B: We were apes, and then we turned into humans.
- Teacher: [Student C], what did you have to say? Was it about evolution?
- Student C: Everyone used to be an ape. That everyone's ancestor used to be an ape.
- Teacher: Everyone's ancestor? What does that mean?
- Student C: It means people from a long time ago, that you don't even know.
- Teacher: So what's the difference between something that you used to be and what your ancestor is?
- Student D: Because when you were in your mom's stomach, you weren't hairy and "apey"!
- Teacher: So that's evolution? That's your definition of evolution. Does anyone else have a definition of evolution?
- Student E: The first people on the world were apes. It was ape, caveman, and then human.
- Student D: No, it was fish, rat, ape, caveman, human.
- Student C: No, its cells!
- Teacher: Oh my, keep going...
- Student D: Cell, ape, caveman, then human.
- Teacher: Does anyone have another definition?
- Student A: Something that was formed... Okay, something that is formed from something else.
- Teacher: So where do birds fit into this? You said they "evoluted." You were talking about how man evolved. How do birds fit in? We talked about cells, we talked about fish...
- Student F: They probably formed from something.
- Student G: We are living through the time, so birds are probably adding onto something.
- Teacher: So how sure are we about this notion of evolution? So pretty much everyone here is saying that humans evolved. So are we pretty sure about this notion of evolution for birds?
- Class: Yes!

This dialogue excerpt is adapted from Resendes, M. & Kici, D. (2014, August). *Connecting to the curriculum: A case study exploring the online and offline discourse of a Grade 2 knowledge building class*. Paper presented at the 2014 Knowledge Building Summer Institute (KBSI), Toronto, Ontario, Canada.

SUSTAINING MOMENTUM: IDEA-CENTRED CLASSROOMS

THE THEORY:

Knowledge Building starts with the inherent natural curiosity of the child and the tendency to play with ideas; but it extends to the unnatural and very challenging process of deliberately improving them. Essentially, while ideas can be easy to generate – the hard part comes when you have to improve them. Idea improvement is a challenging process for experts and novices alike! Lots of great questions and ideas can come out of a discussion or shared experience, but if they aren't recorded anywhere, they can be easily lost or forgotten. **Giving ideas a physical or virtual place to live and grow over time is crucial to supporting sustained idea improvement. As much as possible, make students' ideas visible as they grow!**

Teachers have had great success using these strategies to capture and grow community ideas: **Wonder Walls, KB Walls, and the use of Knowledge Forum.**

“Historically, throughout the world, and across decades and millennia, ideas have been improved. So kids get this sense of, ‘Oh! Einstein’s idea was improved. If Einstein’s idea can be improved, so can mine!’ So...it’s not ‘I was naive, or I was wrong’...but it’s so natural to improve ideas.”

— Marlene Scardamalia



“Whereas idea generation comes naturally to young people, working to improve one’s ideas does not. Considerable support is usually required to maintain student engagement in idea improvement, and even more to establish idea improvement as a classroom norm. But once it is established the students themselves become a sustaining force” (Scardamalia & Bereiter, 2014, pg. 6).

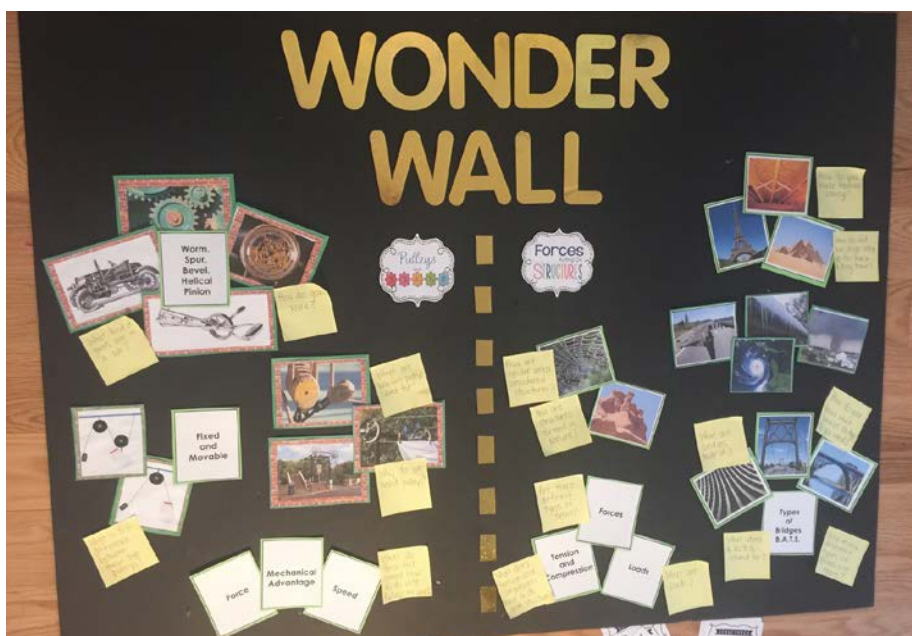
WONDER WALLS

THE PRACTICE:

At the onset of a KB inquiry, have students write down their initial wonderings and questions. Put these up on your classroom wall using sticky notes or pieces of paper with pins (the latter may be preferable as sticky notes can lose adhesion and fall off the wall!). Use these wonderings as visual reminders of long-term goals and guiding questions. Add any new, more refined wonderings, revised and reworked questions, or brand new queries as they arise. Posting a growing body of questions helps students to see the importance of continual questioning and probing throughout inquiry work, and reinforces the idea that questions might change and take new directions over time as students learn more about the problem at hand. As an option, why not place your Wonder Wall outside the classroom? Posting them up in hallways and corridors helps spread curiosity about your classroom KB work throughout the whole school community.

WONDERINGS:

- I wonder why wars can go on so long?
- I wonder why so many species are going extinct?
- I wonder how they can make skyscrapers so tall?



A Wonder Wall. Madly Learning. (2015, June 8). Making a Wonder Wall [Blog post]. Retrieved from: <http://www.madlylearning.com/2015/08/making-wonder-wall.html>

KB WALLS

Learn to thrive in complexity! KB Walls bring idea diversity to life and make student thinking and ideas visible. The visual layout helps students to make connections between ideas, and explicitly shows how their ideas are evolving. The KB Wall examples highlighted in this section were created by Allison Kemper and Elaine Heaver, junior and intermediate teachers from the Hamilton Wentworth District School Board (HWDSB), and their students.

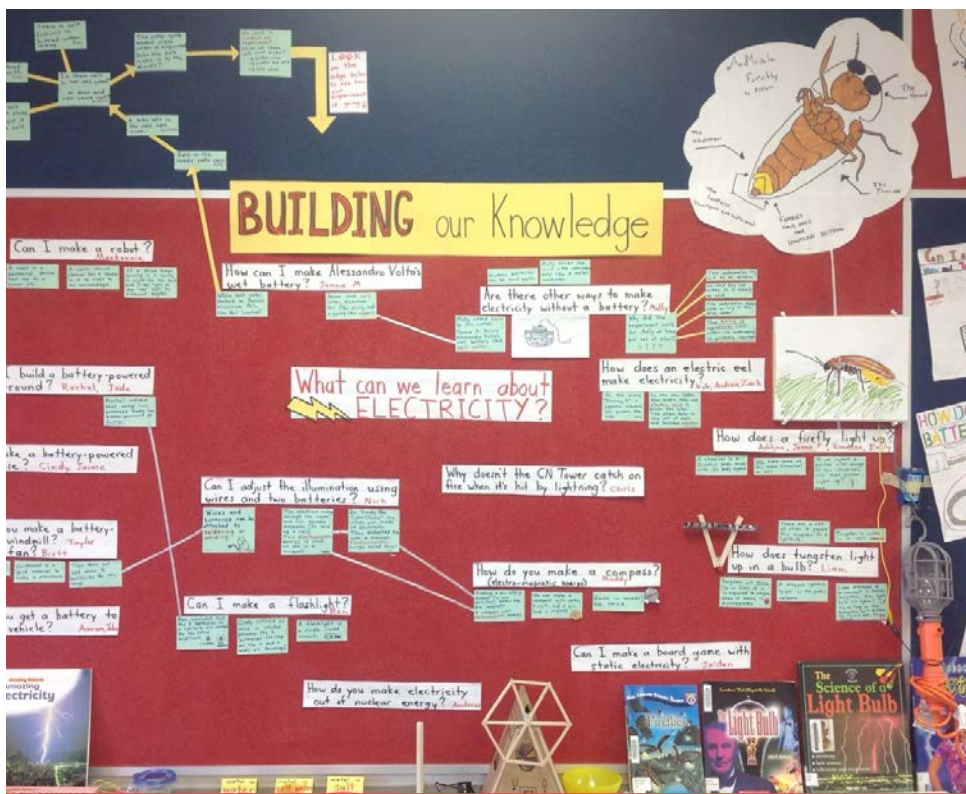


In the KB Wall shown above, Allison Kemper's Gr. 7 students were exploring the big question, "What inspires someone to take a stand?" Students were posing theories, engaging with relevant news articles, and building onto each other's ideas. (You can learn more about the process Allison uses to build her KB Walls with her students in her case study *A Knowledge Building Buffet! Working with Ideas in Grade 7* available in the KB Case Studies package via [The Learning Exchange](http://thelearningexchange.ca/wp-content/uploads/2017/04/3_1-A-KB-Buffer-Working-with-Ideas-in-Grade-7_Accessible.pdf) at http://thelearningexchange.ca/wp-content/uploads/2017/04/3_1-A-KB-Buffer-Working-with-Ideas-in-Grade-7_Accessible.pdf)



Photo 1. A KB Wall exploring big ideas in Biodiversity in Elaine Heaver's Grade 6 classroom.

In Photo 1, two of the Big Ideas from the Grade 6 curriculum Biodiversity unit are posted at the very top of the wall and create the framework for the KB Wall. Three major themes are identified on the larger yellow strips: Interrelationships; *Local and Global Issues*; and *Invasive Species*. Relevant data sources are posted on the top right, while facts and scale drawings of endangered animals are listed on the top left. Students post their ideas and facts from their research on coloured paper squares. Connections between ideas are traced with yellow yarn.



A KB Wall exploring student wonderings around electricity.

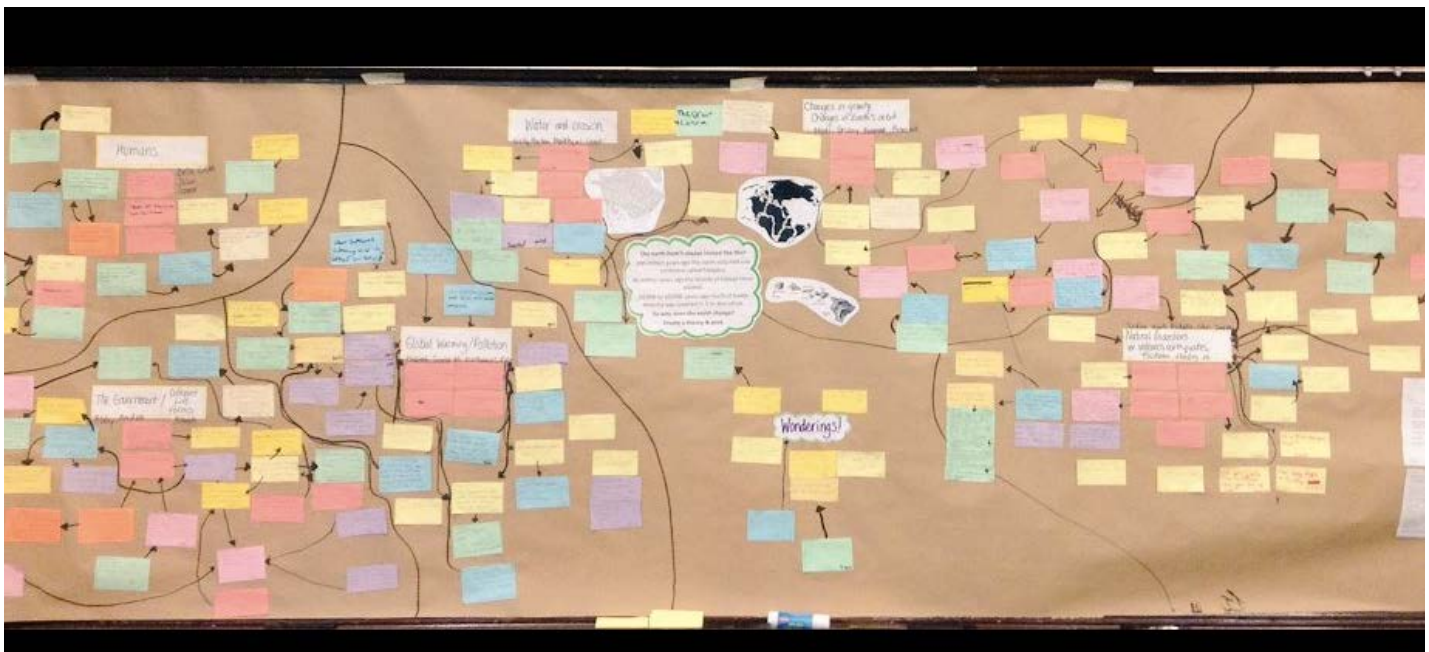


Photo 2. A KB Wall exploring big ideas around geography (land forms) using different coloured paper to indicate different kinds of contributions.



Photo 3. Coloured paper squares featuring a variety of KB scaffolds to use on a KF Wall.

Photo 2 shows another KB Wall focused on Geography. The central question focused on exploring how and why landforms change. Coloured paper squares are labelled with various KB Scaffolds and made available in baskets in the classroom for students to use (see Photo 3). The scaffolds help students to frame their thinking and writing, and encourage them to be meta-cognitive and reflective when making contributions.

HOW CAN I START A KB WALL?

The steps outlined below walk through the process teacher Elaine Heaver used with her Grade 6 students to grow a KB Wall in her class.

- A classroom visit from an astronomer inspired the big question “How did the universe begin?”. This question was posted on the wall. Before doing any research or seeking out information from any kind of authoritative source, students proposed their own original theories and ideas about the question using yellow paper squares labelled with the KB Scaffold “My Theory” (Figure 1).
- Next, students engaged in active research to explore the plausibility of these theories. As seen in Figure 2, as students investigated their ideas, they used green paper squares to record “Evidence to Support” a theory, and red paper squares to indicate “Evidence to Discount” a theory. The use of colour-coded paper squares in this way allowed the community to see at a glance which theories showed more promise and were worth spending more time on. Yarn was used to indicate connections between ideas and build-on contributions.
- The class continued to improve their theories and ideas, using blue paper to pose new questions that were arising and purple paper to make new connections between ideas. The yellow Rise Above arrows at the top of the web were added after initial theories were posed, investigated, and interrogated (see Figure 3). A Rise Above idea is not about selecting between opposing ideas or creating a compromised idea that gives up some of the power of those that play into it. Rather, Rise Above ideas are about “creat[ing] a new idea that preserves the value of the competing ideas while ‘rising above’ their incompatibilities” (Scardamalia, 2004, p. 7). A Rise Above idea is most powerful when it is not simply a summary or distillation of generated ideas, but a genuinely new idea

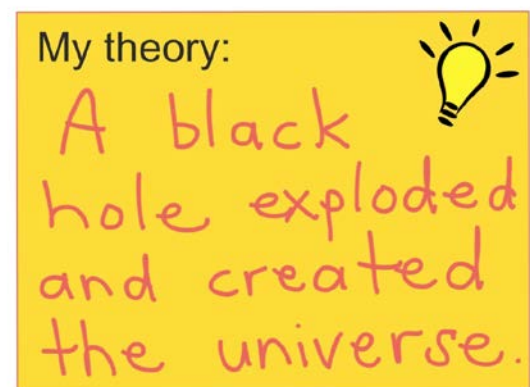
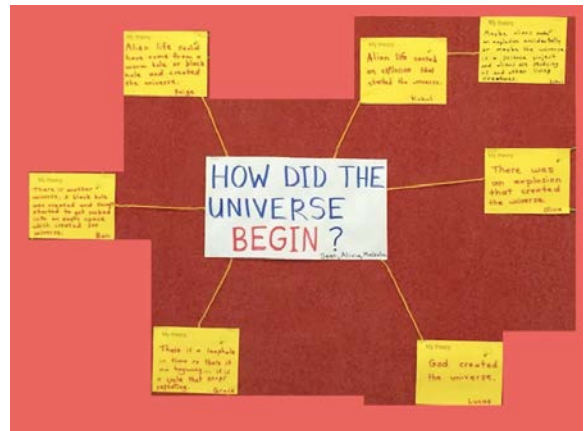


Figure 1. The first step to creating a KB Wall included posting a question or problem and adding original theories on yellow colored paper.



Figure 2. Students add on their “Evidence to Support” (green paper) and “Evidence to Discount” (red paper) contributions.

- that the community recognizes as an advance on previous knowledge. On this KB Wall, these yellow arrows served as visual reminders that encouraged students to take the next step in idea improvement by making connections between ideas to get to new insights, more sophisticated ideas and higher and higher level understandings.

For example, students move from their initial theories such as “black holes created the universe” or “the universe was started by the Big Bang” to higher level conceptualizations and more elaborate theories. A Rise Above contribution might look something like this: “The creation of the universe is more complicated than what we’ve talked about so far. The Big Bang might have happened and is important in understanding the beginning of the universe. But, we also need to

understand a bit of Einstein’s theory of relativity as well as something called Quantum theory to understand how an explosion — or what scientists call a “singularity” — might have happened in the first place. I got some of my information from a famous scientist named Stephen Hawking.” While this entry does not necessarily represent a conceptual breakthrough, it nevertheless attempts to integrate new ideas to existing theories in the effort to deepen understanding.



Figure 3. More student contributions are added; blue paper indicates new questions and purple paper indicates new connections. Yellow arrows remind students to strive to continually rise above existing ideas.

THE USE OF KNOWLEDGE FORUM

Knowledge Forum (KF) is an online community space that is specially designed to support creative work with ideas. It works like a virtual KB Wall, enhanced with powerful assessment tools and automated features specially designed to support Knowledge Building. When Elaine Heaver's class began to run out of room on their KB Walls (see pg. 51-54), they decided to continue their investigation using Knowledge Forum, which afforded them infinite space to develop and grow their ideas. In Figure 4, you can see the original question in the centre, with student ideas branching off. Each contribution is titled in red, and when clicked, will open up to show the students' note, as seen in Figure 5 (for more on Knowledge Forum, see pgs. 96-108).



Figure 4. A Knowledge Forum "view." Red dots indicate student notes, red text are note titles that can be double clicked and opened to reveal note contents (see below).

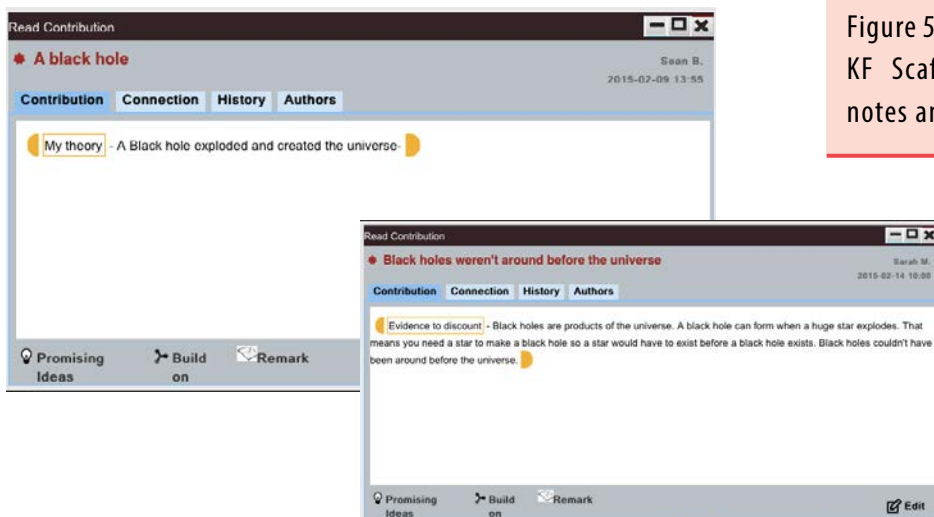


Figure 5. Knowledge Forum notes when opened. KF Scaffolds are automatically available in notes and are framed in yellow.

WHAT OTHER PRACTICES CAN SUPPORT MY STUDENTS IN AUTHENTIC KNOWLEDGE WORK?



“If your road to success is pretty straight, you didn’t challenge yourself!”

— *KB student*



In Knowledge Building, students’ ideas are the catalyst for tasks and activities. Everything begins and moves with students’ own ideas, and the community work that takes place does so in the service of collectively improving them. An **idea-centred classroom** represents a significant shift from a more traditional

activities-based classroom, where completion of tasks and acquisition of established information often pervade over the development of ideas or the building of new knowledge. The short case study on pages 61-63 of this resource tells the story of a Grade 6 Knowledge Building class exploring biodiversity and illustrates what an idea-centered KB class looks like, where tasks and activities are undertaken in service of the organic evolution of students’ ideas.

The journey of idea improvement is not a straightforward one. Knowledge Builders know that they are likely to hit obstacles and roadblocks, make mistakes, discover hidden gems, make unanticipated discoveries, take a wrong turn, and so on. Such a journey is the nature of creative knowledge work; these challenges need to be embraced rather than feared or avoided. Students need to get comfortable with taking risks, experiencing productive struggles, and deciding on strategies to help move their ideas forward. Below is a list of examples of the kinds of activities and practices that students often take on during Knowledge Building to help them improve their ideas:

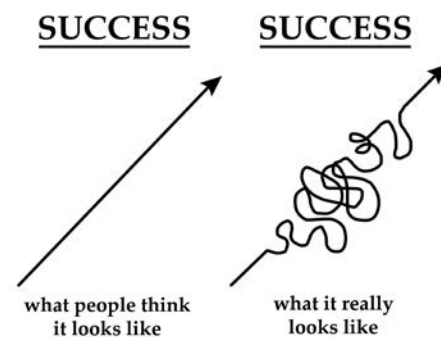


Image attributed to: Dimitri Martin (2011), *This is a book*. Grand Central Publishing.

- Posing and revising theories
- Engaging productively with complementary and contrasting ideas
- Creating strategies to persevere through challenges
- Designing surveys and collecting data
- Analyzing data
- Going on field trips
- Corresponding with experts
- Identifying promising ideas/questions
- Observing and recording
- Designing and conducting experiments
- Investigating and evaluating primary sources
- Organizing work and setting priorities, such as planning next steps, setting and revising goals, etc.
- Creating media artifacts (texts, artworks, videos, sketches, diagrams)
- Engaging in Gallery Walks
- Working constructively with authoritative sources
- Engaging in individual and group reflection on progress, setbacks, challenges, etc.

WORKING WITH IDEAS: STRATEGIES FOR STUDENTS



PROMISINGNESS JUDGMENTS

Recognizing a promising idea is a key marker of creativity and expertise and helps to distinguish creative experts from novices, and even experienced non-experts (Bereiter & Scardamalia, 1993). Assessing ideas for promisingness means continually thinking **which way ahead or do we think this idea is worth spending time on?** Therefore it is important to give students the time and opportunity to make promisingness judgments on their ideas in order to help move Knowledge Building work forward.

Example:

- **Step 1:** Students are exploring a central question or set of questions (e.g., “Why don’t democracies fight each other?” “Why do wars nowadays last so long?”). They spend a week or two proposing initial theories, gathering evidence, data, and information to support, build on, or discount their theories.
- **Step 2:** After this initial phase, there are lots of ideas to work with and many possible directions to pursue. Introduce the notion of “promisingness” to students: Which of our questions and ideas seem to have the most evidential support? Which do we think are worth spending the time to pursue? Students then take a ‘step back’ to assess how promising their own ideas and questions are and select the ideas and questions they judge to be the most promising.
- **Step 3:** As a class, review the promising ideas and questions that were selected. Re-frame if necessary (sometimes students can choose impressive sounding facts rather than promising ideas; alternately, it might take a slight tweak of a question to change it from a fact-based to a promising question — e.g., “What are some reasons the war started?” can be made more promising by being changed to “Why or how was it that this particular event sparked the war?”). Identify the most promising theories and/or questions and make them visible in the classroom (on a KB Wall, on Knowledge Forum, etc.).
- **Step 4:** Students can determine the next “promising ideas session” as they continually refine ideas.

WORKING WITH ASSUMPTIONS

This technique helps to uncover thinking habits and assumptions to help create new perspectives on a given issue or problem. It works effectively for the process of improving a model or product design. The following steps can be taken to help students work with assumptions: 1. Have a clearly defined problem statement or question; 2. List all immediate assumptions related to any aspect of the question. This process is done fairly quickly; 3. Challenge the assumptions by asking “what if...was not true?” 4. Generate new ideas in response to your challenge question.

Example:

- **Step 1:** How can we create a stronger bridge without changing materials?
- **Step 2:** Generate Assumptions: We will have to sacrifice another feature (it can't be as cost-efficient/it can't be as aesthetically pleasing/it needs to be thinner or shorter); we simply can't do this; our bridge needs the highest weight threshold possible; the materials are what make the bridge strong; the design is what makes the bridge strong; we don't have to change materials we just need more of the same materials; etc.
- **Step 3:** Challenge Assumptions: What if having to sacrifice another feature was NOT true? We'd have to focus more on design and physics; What if it's not true that it's all about the design? We'd have to think of how the physical environment enhances the materials, etc.
- **Step 4:** Generate New Ideas: Let's focus on redesign, and do more to explore different bridges around the world to see how we can adopt some new ideas and strategies into our own work.

HOW? WOW! NOW!

This tool helps a team create original ideas that can be implemented and acted upon quickly (see <http://www.innovationgames.com/how-now-wow-matrix/>). The tool is a square template divided into four smaller squares (see Figure 6). The X and Y axis of the matrix denote: 1) Originality of ideas and 2) Feasibility of implementation. Each box is colour-coded. The blue box represents "blue sky" ideas that are inspiring and imaginative but that would be difficult or impossible to implement quickly; the purple box represents exciting and innovative ideas that are actually feasible to execute; the green box represents less creative but useful ideas that could be implemented very easily. You can use the tool to help generate ideas or to help classify ideas that have already been proposed.

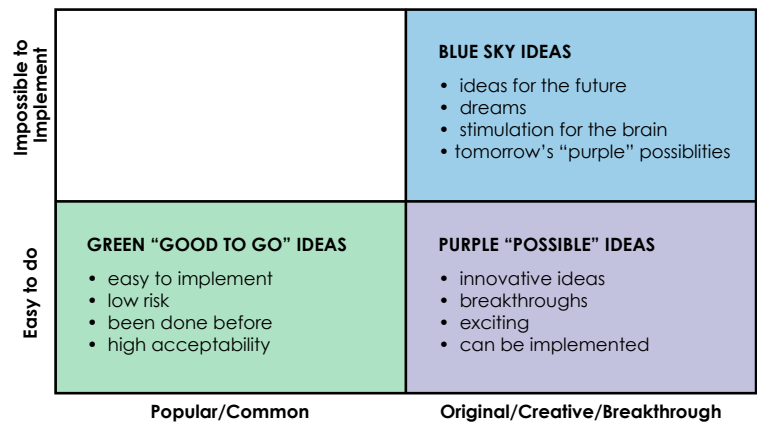


Figure 6. How! Wow! Now! Matrix

Example:

Students are working on a way to increase awareness in their community about how many families rely on food banks and donations in their area and on how hunger and poverty impact students' achievement in school. They have lots of ideas of ways to get involved in the issue, to educate the community, to engage with their local government, and so on. The How? Wow! Now! matrix can help them organize their many ideas into a plan that can help move their ideas into action.

“WISDOM OF THE CROWD” PROTOTYPING

This process is inspired by a class of KB Kindergarteners who were exploring flight. The process is great for both collaboratively generating and improving ideas, designs, and models. Check out a video of this class’s work [here](#) or visit <https://vimeo.com/93267197>

- **Step 1:** Design and build a prototype product/model. Together, everyone gets to test their designs.
- **Step 2:** As a collective, examine each existing design/product for strengths and benefits.
- **Step 3:** Make a list of observations and ideas about the positive and negative qualities of each current design. Identify the ‘key’ elements, the most/least effective components, the materials, etc.
- **Step 4:** Brainstorm ideas for improving the design/product. Use effective brainstorming techniques — no idea is too silly or fantastical not to be considered; generate as many ideas as possible; organize and move ahead with the most promising ideas.
- **Step 5:** Re-design and re-test the product or design based on the knowledge and ideas generated in Step number 2.
- **Step 6:** Repeat as necessary.



Example:

- **Step 1:** To explore the elements of wind, students created their own paper “airships.”
- **Step 2:** The class went to the gym with a big fan. Each student tested how far their airship flew, propelled by the fan. Students marked each airship’s distance on the gym floor.
- **Step 3:** After the trials, students returned to class to assess why certain airships flew farther than others. They evaluated the strengths and weaknesses in each other’s designs.
- **Step 4:** Students did research to help improve their ideas (read books, talked to a pilot, etc.). Students re-designed their own original airships.
- **Step 5:** Students brought their second, improved designs to the gym for another set of trials. After the tests, students again returned to class to discuss results and reflect on what they had learned.

GROUP REFLECTION, OR META-TALK IN KB

Meta-talk is another critical element of Knowledge Building. Meta-talk can be defined as “discourse about progress and difficulties in the main knowledge-creating effort” (Bereiter & Scardamalia, 2014, p. 46). It is important that students engage in both self and group meta-talk/reflection to assess the community’s progress, identify shared gaps in understanding, and so on. Meta-talk sounds something like this:

“LET’S LOOK AT OUR DATA AND SEE HOW WE’RE DOING.”

“WE SEEM TO BE STUCK. WHAT CAN WE DO TO ADVANCE?”

“GOOD WE CAUGHT THIS MISTAKE EARLY.”

“OUR BEST INSIGHT SO FAR.”

“THE IDEA THAT REALLY NEEDS WORK.”

Use the prompts below as a guide for repeated group reflections. These can be especially useful at the end of a KB Circle, or you can periodically dedicate whole KB Circle times specifically for group reflection. The **KB Progression Charts** (see pgs. 65-69) provide strategies for advancing ideas and deepening discourse that could inspire your own Meta-talk questions and prompts.

RECONNECT AND REFLECT!

“ARE OUR COMMUNITY’S IDEAS IMPROVING? HOW DO WE KNOW?”

“ARE WE IMPROVING OUR THEORIES? EXPLORING OUR QUESTIONS?”

“IS EVERYONE IN THE COMMUNITY ENGAGED? IF NOT, HOW CAN WE GET EVERYONE ENGAGED AND CONTRIBUTING?”

“WHERE ARE WE STUCK? HOW CAN WE MOVE FORWARD?”

“WHAT DO WE STILL NEED TO UNDERSTAND?”

“WHAT IS A USEFUL NEXT STEP?”

**“WHAT ARE OUR BEST KNOWLEDGE ADVANCES AT THIS POINT?
LET’S TELL THE STORY OF HOW OUR IDEAS HAVE IMPROVED SO FAR!”**



CASE STUDY (GRADE 6): DOES EVERY LIVING THING NEED OXYGEN?

This case study describes part of a Grade 6 Knowledge Building study in science, with a focus on biodiversity. The work took place in Elaine Heaver's classroom at Guy B. Brown Elementary School in Waterdown, Ontario. As Elaine explains, one of the KB Principles that helped guide her teaching approach in this class was **Improvable Ideas**. To her, this principle meant that students would put forth ideas, then collaboratively explore them under a closer lens. They would work to gain a better understanding in order to refine their original ideas. (Also available in the KB Case Studies package via [The Learning Exchange](http://thelearningexchange.ca/wp-content/uploads/2017/04/2_2-Exploring-Electricity_Accessible.pdf) at http://thelearningexchange.ca/wp-content/uploads/2017/04/2_2-Exploring-Electricity_Accessible.pdf)



KB PROVOCATION:

Before exploring the biodiversity of living things, we began with the question, “**How do we know if something is living?**” Students posed theories:

- “It grows”
- “It can move”
- “It reproduces”
- “It needs water, oxygen, and food”

We then looked at each of our ideas with a closer lens. **Rather than research what other people had found, we began by drawing on our own knowledge and experiences to see if we could discount or support our theories.** For example, for the idea that all living things can move, students brainstormed and discussed the limited mobility of things like coral, moss, and trees. Through this discussion, they decided that while the ability to move is critical for most species' survival, it is not one of the criteria to determine if something is living. Throughout this phase, students were attempting to find answers by using their combined knowledge, experiences, and conjectures. They were problem solving as a learning community.

STRATEGIES FOR SUSTAINING IDEA IMPROVEMENT:

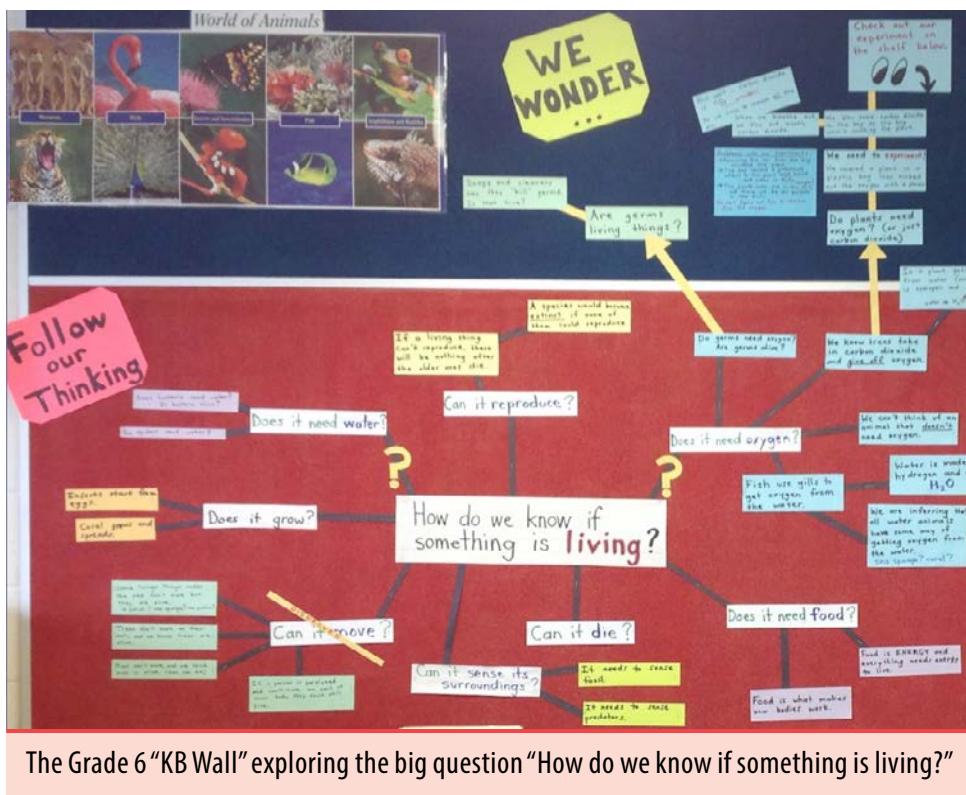
The theory that pushed our thinking the most was, “All living things need oxygen.” Students could not think of a land animal that didn't require oxygen. Since water contains oxygen, the students inferred that water animals have some way of getting oxygen from the water (e.g., fish use gills). Students agreed that an inference is not evidence (and most were confident there were creatures in the ocean yet to be discovered), so we couldn't make any firm conclusions about water animals.

Setting aside land and water animals, **students continued to brainstorm, hypothesize, and challenge ideas in order to determine if all living things needed oxygen.** For example, some students had the following conversation:

- “Do germs need oxygen?”
- “Are germs living things?”
- “Soap and hand sanitizer say they *kill* germs, so germs must be alive.”
- “Maybe it’s false advertising. People might buy the soap because *killing* germs sounds more powerful than *getting rid of* germs.”

These student discussions helped us determine what we knew and what we needed to find out. **Students then designed experiments to test their ideas.**

- “Trees take in carbon dioxide and give off oxygen. They *produce* oxygen, so they don’t need it.”
- “How do we know plants don’t need oxygen? Maybe they produce it but also have to take it in.”
- “We could make an experiment to see if a plant dies without oxygen.”
- “But plants need water, and there’s oxygen in water. So if you water the plant then it is still getting oxygen.”
- “My mom has plants that she only waters every couple of weeks. What if we get a plant that doesn’t need water for a long time? Then we’ll seal it in a plastic bag without oxygen and see if it dies before it dries out.”



I supplied students with two ferns that the nursery assured me could go two weeks without water. They covered one in a clear plastic bag then sucked out the air from the bag with a straw.

- “Wait. The bag is crushing the plant now that we sucked the air out. If the plant dies, it might be because it’s crushed.”
- “We can use the straw to blow air back into the bag because we blow out carbon dioxide from our lungs — not oxygen.”

Students filled the bag up by blowing through a straw.

We recorded this step on our KB wall. When seeing it in writing, one of the students asked,

- “Why is it called carbon dioxide? Does dioxide have oxygen in it?”

This led to an impromptu mini-lesson on chemical notation. Students at the whiteboard started recording what we already knew (e.g., the symbol of H₂O meant water contains hydrogen and oxygen; a student knew about CO₂ canisters so provided the symbol for carbon dioxide; CO detectors gave us the symbol for carbon monoxide). We looked at how the nomenclature of compounds tells us what elements are in the compounds and how many atoms of each element there are.

This was bad news for their plant experiment:

- “So the carbon dioxide we blew into the bag contains some form of oxygen. We need to take it out again...but removing the air from the bag crushes the plant.”
- “And what about the soil that the roots are in? There are going to be air pockets in the soil, so the plant can be getting oxygen through its roots...but if we remove the soil, the plant will die from lack of nutrients.”

As the students struggled with a way to remove all of the oxygen from the bag and soil, a new complication arose. Students noticed the inside of the bag was wet — moisture was forming. This circled back to the problem that oxygen can be found in water. As one student noted, the plant was sneaking oxygen from everywhere!

Students made a list of *Problems with our Experiment*. They could not think of a way to remove all of the oxygen from the plant’s environment. They came to the conclusion that oxygen is a major part of our environment and our existence. It seems to be everywhere. Their explorations helped them realize the pervasiveness and abundance of oxygen, which in turn sparked an environmental discussion of the importance of keeping our planet’s oxygen supply clean.

At this point, students wanted to find out what scientists have concluded. They were not too surprised to find out that there is not a definitive answer to the question, “Do all living things need oxygen?” Working through this problem at their own level gave them an appreciation of its complexity (e.g., the myriad of variables, the diversity of our planet). It was a reminder that learners take opportunities to continually improve their ideas as they build their knowledge.

Teacher Reflection:

Through this process, students put forward their ideas, and then worked collaboratively to improve upon these ideas. In doing so, their Knowledge Building was not about arriving at a final answer, but rather the process of improving their understanding to advance their ideas.



HABITS OF MIND AND PRACTICES

- **Start from real ideas, authentic problems** that genuinely interest students.
- **Generate original ideas and theories** from students' own thoughts and prior knowledge. All ideas are welcomed — it's not about "the right answer"!
- **Keep ideas at the centre** — be flexible, responsive and adaptive to emerging knowledge and ideas as they arise.
- **Make ideas visible** and keep doing so over time to chart the course of idea development.
- **Commit to improving ideas** through creative knowledge work — observations, experiments, surveys, research, modelling, data collection, critical evaluation of ideas (What are our most promising ideas? How does this idea help us move forward? etc.).
- **Engage in frequent community KB talks** — KB Circles, group reflection, use of Knowledge Forum to share and build on ideas, etc.
- **Use KB Scaffolds** in face-to-face and online discourse.
- **Be goal-oriented but open and flexible** — keep a growth mindset!
- **Aim for continually Rising Above** — not just summarizing information but adding something new that moves ideas forward, reframes a problem, takes ideas in a new and deeper direction, etc.
- **Embed teacher and student-driven assessment** throughout the process (both individual and group assessment).
- **Engage in frequent individual and group reflection** — for individuals it's not just about asking "how am I doing?" but also "how am I contributing to the group effort? How am I helping the community to advance on its goals?"

For the community, it's about assessing collective advances and challenges: ***"Are we as a group progressing on our ideas and advancing our knowledge?" "Where are our knowledge gaps? What is our next move?"***

KNOWLEDGE BUILDING PROGRESSIONS

Knowledge Building teachers, educational leaders, and researchers collaboratively designed a series of Knowledge Building Progressions to help map out what a trajectory of deepening Knowledge Building practice looks like. Four dimensions of Knowledge Building are considered in the KB Progressions, including:

- Fostering Collective KB Discourse
- Community Norms
- Developing Ideas
- Meta-Cognition/Meta-Talk

Teachers can use these Progressions to evaluate data and evidence that has been gathered from classroom activity throughout the duration of KB work. The Progressions can also help **teachers to see themselves within the trajectory, both as an aid for self-reflection and as a guide for goals and ways to move forward.**

The practices and Look Fors described in the KB Progressions can also be used to inform assessment and evaluation. For example, many of the behaviours and activities outlined in the Progressions are directly aligned with the Ontario Report Card Learning Skills and Work Habits, providing a coherent framework for reporting student achievement on key evaluation indicators (see the Evaluation and Reporting section, pgs. 126-135 for a more detailed discussion).



KB PROGRESSIONS: HOW TO GROW A KB CULTURE IN THE CLASSROOM

| | Early Practice | Developing Practice | Deepening Practice |
|--|--|---|--|
| Fostering collective KB Discourse | Look Fors | Look Fors | Look Fors |
| What the teacher does | <ul style="list-style-type: none"> Teacher selects, introduces, and models KB Scaffolds. Teacher initiates discussions about the role and use of KB Scaffolds in sharing thinking through discourse (e.g., KB Circle, Knowledge Forum). | <ul style="list-style-type: none"> Teacher encourages and highlights KB Scaffolds that are not being used. Teacher helps students realize that there are different prompts for different purposes. Teacher recognizes when students are using a variety of KB scaffolds in their discourse. Teacher may introduce new KB Scaffolds. | <ul style="list-style-type: none"> Teacher recognizes that KB Scaffolds are fluid in the discourse. Teacher promotes the use of KB Scaffolds to help students explore the ideas that have not been developed or the outlier ideas in the discourse. Teacher is looking for an increasing overlap between students' vocabulary and expert vocabulary (curriculum terms). Teacher encourages students to suggest new Scaffolds as the discourse evolves. |
| Key questions to ask yourself | <p>"Am I paying attention to the KB Scaffolds?"</p> <p>"Are my students given multiple opportunities to use the KB Scaffolds/engage in KB Discourse?"</p> | <p>"How can I identify gaps in the use of KB Scaffolds? (Are students using evidence to support their theories? Are they making attempts to connect their ideas?)"</p> <p>"Am I giving students opportunities to reflect on KB Scaffold use? Do students have opportunities to evaluate, identify and select scaffolds that are of most use to them?"</p> | <p>"Are ALL my students using KB Scaffold-driven discourse?"</p> <p>"Are students able to identify the KB Scaffolds they've been using?"</p> <p>"What strategies are they using to help them deal with challenges and disagreements productively?"</p> <p>"How can my students be encouraged to contribute more diversely (use higher level KB Scaffolds?)"</p> |
| What the students do | <ul style="list-style-type: none"> Students explore and practise the use of a variety of KB Scaffolds to share their thinking in their discourse (e.g., use anchor chart of KB Scaffolds during a KB Circle; use the KB Scaffolds when writing on Knowledge Forum). | <ul style="list-style-type: none"> Students are taking a risk in exploring and using a variety of KB Scaffolds in their discourse. Students co-create KB Scaffolds with their teacher. Students recognize the collective responsibility to contribute to the community through their discourse. | <ul style="list-style-type: none"> Students are using a variety of KB Scaffolds in their discourse. Students understand that different KB Scaffolds lead to different thinking in their discourse. KB Scaffolds use is helping to produce new emerging ideas and to advance existing knowledge. Students are creating new scaffolds as needed. |

| | Early Practice | Developing Practice | Deepening Practice |
|-----------------|---|---|---|
| Community Norms | Look Fors | Look Fors | Look Fors |
| | <ul style="list-style-type: none"> • Teacher co-creates a culture of collaboration and communication with students. • Teacher explicitly models norms through a variety of activities. • Teacher and students co-create norms of collaboration and communication. • Students practise norms of collaboration through a variety of activities (e.g., fishbowl) | <ul style="list-style-type: none"> • Teacher provides opportunities for students to consistently collaborate in small/whole group discourse. • Teacher listens for student use of collaboration and communication norms and prompts as needed. • Teacher is modeling by clarifying, validating, and making connections (e.g., I like the way you are thinking, that is an interesting idea...) • Teacher takes on role of facilitator in the KB community, monitors individual and group discourse, learning through observation, conferencing, and KB Circles. • Teacher acts on opportunities to help learning go in new directions (e.g., giving students an opportunity to design and experiment). • Students are able to demonstrate collaboration and how they help build a sense of community. • Students are using appropriate language and behaviours (e.g., turn taking) to respectfully challenge or add on to each other's thinking. • Students are showing evidence of helping to establish a culture of trust, acceptance and safety. • Students are open to diverse ideas and individual differences between one's own ideas and the ideas of others. | <ul style="list-style-type: none"> • The classroom community is a community of researchers who continually take their observations back to the group so the community can further explore them. • The community reflects on its progress, challenges, state of ideas and knowledge, social and community dynamics and characteristics (see pgs. 106-108 for how Knowledge Forum's assessment tools can help!) • Students are now acting and thinking as mathematicians, historians, scientists, sociologists, etc. • Students have a collective responsibility to ensure norms of collaboration are being used effectively (e.g., student directed instructions, student self-assessment). • Students take a leadership role in facilitating discourse (e.g., students challenge others' thinking). • The community connects directly with one another (students are engaged with one another and not reliant on the teacher for validation). • Students are able to handle challenges and setbacks. • Students share ideas and expertise within and between groups, teams, and classrooms. • The community co-constructs knowledge across groups, teams, and classrooms. • Students apply a "KB Stance" to other subjects and situations outside the walls of the classroom. |

| | Early Practice | Developing Practice | Deepening Practice |
|------------------|---|---|---|
| Developing Ideas | Look Fors | Look Fors | Look Fors |
| | <ul style="list-style-type: none"> Teacher provokes ideas and wondering and encourages that <i>all ideas are improvable</i>. Teacher supports students in contributing their ideas and thinking. Teacher helps students identify preconceived notions, biases, and misconceptions. Teacher engages students in discourse in Knowledge Forum (see pgs. 55, 96-108, 78-82). Teacher engages students in discourse through KB Circles (see pgs. 45-48). Students consider and share their own ideas. Students may not accept the ideas of others. Students may be stuck in their thinking and don't yet have the strategies to move forward. | <ul style="list-style-type: none"> Teacher provides links/connections to experts within the community. Teacher encourages students to consider alternative perspectives via conferencing, KB Circles. Teacher ensures students have access to a variety of authoritative sources Teacher recognizes whether the discourse being used by students matches expert discourse. The community supports and challenges student thinking (e.g., validating of sources, whose voice is missing?, preconceived notions or bias). Students demonstrate value for idea diversity through their discourse. They value group thinking and the ideas of others (e.g., family members, experts and community members). Students explore a variety of perspectives/sources and are allowed time to puzzle and pursue different paths/problem solving strategies. | <ul style="list-style-type: none"> The community can see that their knowledge is advancing and their ideas are improving. The community is able to identify their deepest thinking and what helped them advance their ideas. They can tell the story of how their ideas have improved! The community demonstrates an understanding that all ideas are improvable through their discourse (e.g., risk-taking, finding innovative solutions, connecting ideas, synthesizing knowledge, considering a variety of perspectives and sources). The community uses authoritative sources constructively to support idea development. |
| | <p><i>"Are all my students engaged?"</i></p> <p><i>"Are there opportunities for students to contribute in different ways?"</i></p> | | |

| | Early Practice | Developing Practice | Deepening Practice |
|------------------------------|--|--|---|
| Meta-Cognition/ Meta-Talk | Look Fors | Look Fors | Look Fors |
| | <ul style="list-style-type: none"> Teacher and students co-design the learning/community goals (e.g., using the Big Ideas in the curriculum to co-design learning/knowledge goals with students). What are you interested in? What are you wondering about? What do you want to know about X? (See pgs. 35-37 for provocation ideas). The community will talk about their comfort in learning, their own learning experiences, and the community dynamics of the classroom. | <ul style="list-style-type: none"> Teacher uses data from discussions/ conferencing and observations to determine next steps to support student thinking. Perhaps some teacher-directed lessons are needed to address student misconceptions. | <ul style="list-style-type: none"> Teacher facilitates discourse that prompts students to realize their next steps (e.g., conferencing, exit cards). Students articulate how their thinking has changed and what or who influenced their ideas through the discourse (both in the classroom and beyond). Students have reached an awareness that there is no fixed product or definite end. You can always dig deeper and learn more. Students are proactive in their learning, their engagement in KB Discourse, and what they contribute to the collective knowledge. Students can clarify areas of disagreement and shared gaps in understanding. Students engage in high level tasks like setting long-term goals, planning next steps, evaluating progress in light of new learnings. Students are able to achieve new syntheses, form high level ideas, concepts and solutions (e.g., Rise Above ideas) Students are able to review progress regularly through group and self-reflections. |

KNOWLEDGE BUILDING IN MATH

KNOWLEDGE BUILDING IN MATH: HOW DO WE HELP STUDENTS TO THINK LIKE MATHEMATICIANS?

How can we help support the shift from “learning math” to students’ “thinking like mathematicians?” Like all Knowledge Building, the approach in math is collaborative and inclusive; it requires that students and teachers work together on achievement objectives, and that students take high-level responsibility for goals and outcomes — and especially for idea improvement. In this section, we focus on how Knowledge Building can be applied to mathematics across all Grade levels.

CURRICULUM CONNECTIONS

A KB approach to math engages students in the **key mathematical processes** that support effective learning in math, as outlined in the Ontario curriculum document. When students are engaged in Knowledge Building to advance mathematical understanding, they are:

- Problem Solving
- Reasoning and Proving
- Reflecting
- Selecting Tools and Computational Strategies
- Connecting
- Representing
- Communicating

“Problem solving is central to learning mathematics. By learning to solve problems and by learning through problem solving, students are given numerous opportunities to connect mathematical ideas and to develop conceptual understanding. Problem solving forms the basis of effective mathematics programs and should be the mainstay of mathematical instruction” (*The Ontario Curriculum Grades 1-8, Mathematics, 2005*, p. 11).

Moreover, Knowledge Building promotes the development of an effective pedagogical system for math learning (Anthony & Walshaw, 2007), which includes:

- A non-threatening classroom environment
- Worthwhile math tasks
- Classroom discourse
- Tools and representations

The mathematical processes and the elements of an effective pedagogical system outlined above are underscored in the Vision for the Mathematical Learner, which informs Ontario’s Renewed Math Strategy, 2016 (see http://www.edu.gov.on.ca/eng/policyfunding/memos/april2016/min_math_strategy.html).

The Vision for the Mathematical Learner is summarized in the chart.







| Vision for the Mathematical Learner | |
|--|---|
| Understands Math Concepts | Students engage in learning opportunities that: <ul style="list-style-type: none"> • Develop conceptual understanding • Make connections among mathematical ideas • Show mathematical thinking using models, tools, and representations |
| Is Proficient with Facts, Skills, Procedures | Students engage in learning opportunities that: <ul style="list-style-type: none"> • Provide meaningful practice in a variety of ways • Foster the use of appropriate mathematical language, notations, and symbols to communicate • Support consolidation and mastery of learning |
| Engages in Mathematical Processes | Students engage in: <ul style="list-style-type: none"> • Problem Solving • Reasoning and Proving • Reflecting • Selecting Tools and Computational Strategies • Connecting • Representing • Communicating |
| Demonstrates Autonomy and Self-Regulated Learning | Students have an active role in: <ul style="list-style-type: none"> • Developing understanding of learning goals and success criteria • Applying criteria, monitoring progress, reflecting, and setting individual learning goals • Developing and practising peer and self-assessment |
| Displays A Positive Attitude Towards Mathematics | Students experience a learning environment that: <ul style="list-style-type: none"> • Feels safe to wonder and take intellectual risks • Develops self-efficacy, resilience, and a growth mindset • Positions them as mathematical thinkers and doers • Fosters an appreciation for math as an important tool in daily living |







CONNECTIONS TO THE KNOWLEDGE BUILDING PRINCIPLES

The key math strategies described above are aligned with the **12 Knowledge Building Principles** (see pgs. 20-26), which support student engagement, confidence, and achievement in math. By providing explicit opportunities for students to work with the KB Principles and to experience what they look and feel like in their math learning, we allow all students the opportunity to develop the skills of a mathematician. For example:

- **Real Ideas, Authentic Problems:** This principle involves engaging students in problems involving math that spark their natural curiosity, which can help them both develop their understanding and form positive attitudes towards the subject (Colgan, 2014).
- **Improvable Ideas:** This principle centres on the notion that “all ideas are improvable” and helps to encourage a “growth mindset” (Dweck, 2006), which, when applied to the domain of math, can help boost learner confidence and development (Sirois, 2014).
- **Knowledge Building Discourse:** The importance of mathematical discourse — “math talk” — to achievement and engagement in the subject is well known (NCTM, 2000; National Research Council, 2001). In a Knowledge Building community, opportunities for members to engage in peer-to-peer Knowledge Building Discourse are a priority.

The chart below suggests an alignment between the KB principles, and different aspects of the Vision for the Mathematical Learner. It includes examples of student KB Discourse from a Grade 6 KB classroom that illustrates engagement for each category.

| KB Principle | Vision for the Mathematical Learner | Student KB Discourse |
|--|--|--|
|  Real Ideas, Authentic Problems | Displays a Positive Attitude Towards Mathematics | "What percentage of the world has access to clean water?" "How do some people live on \$1 a day?" "Why might the amount of this shopping list for our pie ingredients be over the budget we had?" |
|  Idea Diversity | Understanding Math Concepts Is Proficient with Facts, Skills and Procedures Engages in Mathematical Processes | In a KB Circle: Student 1 Shared: "13% of Afghanistan's population has clean water." Student 2 shared: "84% of Cambodia's population does not have clean water." "I never realized that there are two ways to represent similar information." "There is only a 3% difference between the two countries." |
|  Improvable Ideas | Understands Math Concepts Is Proficient in Facts, Skills, and Procedures Engages in Mathematical Processes Displays a Positive Attitude Towards Mathematics | Student 3 shared that 13% of Afghanistan's population actually does not have clean water; the class then decided to use the stat from Cambodia to test this idea: "Let's draw this idea out in a circle graph/pie chart, and see if it makes sense." They discovered it was a misconception: "If 13% of the population doesn't have clean water then the country would not be in a Water Stress." |
|  Knowledge Building Discourse | Understands Math Concepts Engages in Mathematical Processes Displays a Positive Attitude Towards Mathematics | Students were working on designing the ideal city. They encountered a couple of problems: "If we are saying that all tuition will be paid for homeless people in our Helping Hands Shelter, where would the money come from?" "How do we handle population growth if we only have 5 residential homes in this city?" "Building onto the theory of dividing by 5, I'm thinking we could use the calculator to compare solutions." |
|  Community Knowledge, Collective Responsibility | Understands Math Concepts Is Proficient with Facts, Skills and Procedures Engages in Mathematical Processes Demonstrates Autonomy and Self-Regulated Learning | Students were working on a math problem involving distributing pies: "We need everyone's idea of how to multiply these measurements enough times so that there is enough pie crust for all of the pies." "If we don't figure this out, we will run out of ingredients, and/or everyone won't have a pie to make." |
|  Epistemic Agency | Understands Math Concepts Engages in Mathematical Processes Demonstrates Autonomy and Self-Regulated Learning | "I'm skeptical of your theory. If we used that strategy, this would change the meaning of the number. I think we should take a closer look at place value here." |

| KB Principle | Vision for the Mathematical Learner | Student KB Discourse |
|---|---|---|
|  Rise-Above | <p>Understands Math Concepts Is Proficient in Facts, Skills, and Procedures</p> <p>Engages in Mathematical Processes</p> <p>Demonstrates Autonomy and Self-Regulated Learning</p> | <p>"We are missing something because all of our ideas for population numbers don't make sense."</p> <p>"We are going back and forth with too many numbers 15,000-100,000. What are we missing?"</p> <p>"What do we need?"</p> |
|  Embedded, Concurrent, & Transformative Assessment | <p>Engaging in Mathematical Processes</p> <p>Demonstrates Autonomy and Self-Regulated Learning</p> | <p>Accountable Number Talk/KB Circles:</p> <p>"I'm wondering why my answer is different than everyone else's. Did anyone notice that?"</p> <p>"I see you went wrong, you just needed to subtract the other group of 8."</p> <p>"Let's try to use more of the math terms from the word cloud, to increase the number of mathematical terms in our KF discussion" (see pg. 84-88 for more information on the word cloud).</p> |
|  Pervasive Knowledge Building | <p>Displays a Positive Attitude Towards Mathematics</p> | <p>"This weekend, my mom was sharing about how Parent Council takes a certain percentage of pizza sales and that money helps to pay for some school trips. Would something similar work for our baseball ticket sales and school fees?"</p> |
|  Constructive Use of Authoritative Sources | <p>Engaging in Mathematical Processes</p> <p>Demonstrates Autonomy and Self-Regulated Learning</p> <p>Displays a Positive Attitude Towards Mathematics</p> | <p>"How do mathematicians or experts use mathematical terms, when speaking about math?" "Let's compare our terms with expert terms."</p> <p>"We used 5 expert terms..." (see pg. 84-88 for more information).</p> <p>"How would a real city planner be able to estimate the population when building homes in the community?"</p> |
|  Democratizing Knowledge | <p>Engaging in Mathematical Processes</p> <p>Displays a Positive Attitude Towards Mathematics</p> | <p>"Let's ask the whole group if they have any ideas of where the buildings should be located, since we are making changes from the 2D map to our 3D model."</p> <p>"___ inspired me to think of this solution in a different way."</p> |
|  Symmetric Knowledge Advance | <p>Demonstrates Autonomy and Self-Regulated Learning</p> <p>Displays a Positive Attitude Towards Mathematics</p> | <p>"I'm wondering if we could take the baseball ticket money, and give it to the Helping Hand University Fund."</p> <p>"Can everyone try to explore my idea? I think it may work with everyone's help."</p> |



"The 12 Principles are components of a complex process, and the really good news is that any single one that you unlock helps to unlock the others... focus on whichever one appeals to you." — *Marlene Scardamalia*



BUILDING THE FOUNDATIONS OF A KB COMMUNITY IN THE MATH CLASSROOM

A safe classroom environment and a collective culture that values deep thinking, wonderment, and idea improvement are key to a healthy and thriving Knowledge Building community. The importance of nurturing such classroom conditions cannot be overstated! If learners don't feel safe, if there isn't a commitment to idea improvement and risk-taking, it will be a great challenge to build a healthy Knowledge Building community. Indeed, creating the kind of climate and culture that allows KB to thrive in the classroom can start from the first day of school and can encompass many different elements of the classroom (see the section Growing a Knowledge Building Culture, pgs. 18-33). Engaging in idea improvement around mathematics offers some great opportunities for concurrently both developing a KB culture and for engaging students in deep thinking and key mathematical processes.

SOME KEY IDEAS

There are a number of approaches teachers can take to engage Knowledge Building for math. For example, students can tackle a pre-defined math problem, or they can grapple with a real-life issue where math can be emphasized. Whatever the approach, there are some common key ideas and practices teachers can adopt to engage critical Knowledge Building Principles in their classroom:

- **FOCUS ON COLLABORATIVE KB DISCOURSE:** Collaborative strategies such as Gallery Walks that allow for *Idea Diversity*, and *Democratizing Knowledge* can be integrated to help students build on one another's ideas and strategies. To ensure that all ideas become a part of the community's collective knowledge, after small group work or activities like Gallery Walks, ideas from all students are discussed by the whole class in **KB Circles**.
- **MAKE THE GOAL OF DISCUSSION IDEA IMPROVEMENT:** Collaborative discourse focuses on idea improvement rather than getting at the right answer speedily. The discussion is a key time for the teacher to assess students' level of understanding and to plan the next instructional move.
- **INTEGRATE CONSTRUCTIVE USE OF AUTHORITATIVE SOURCES:** Authoritative sources that engage whatever concept is being dealt with, and/or results of student experimentation and testing (e.g., models and drawings) would be used during discussions. Any student artifacts or resources created during small group or individual work time could serve as objects of inquiry for discussion. (Alternately, these artifacts could also be photographed and put inside **Knowledge Forum** as objects to ground further discussion and exploration (see pgs. 96-108 for more information).
- **INTEGRATE MINI-LESSONS FOR SUPPORTING PROCEDURAL KNOWLEDGE:** Teacher-directed mini-lessons can be one approach for supporting learning of mathematical facts, vocabulary, conventions, etc., such as times tables. These should be integrated within collaborative activities as teachers assess gaps in student understanding.

The following section outlines a tangible process that focuses on bringing important KB principles, such as **KB Discourse**, and **Community Knowledge, Collective Responsibility** to life through practical strategies and concrete activities in the mathematics classroom. (Watch the video series Innovations in Thinking and Learning: Reflections and Lessons - Grade 6 [here](#) or Math in Action [here](#) to see KB mathematics classes in action; or, check out the KB Case Studies package at <http://thelearningexchange.ca/wp-content/uploads/2017/04/Knowledge-Building-All-Case-Studies-Accessible.pdf> for a variety of math-related case studies).

POSSIBLE METHOD:

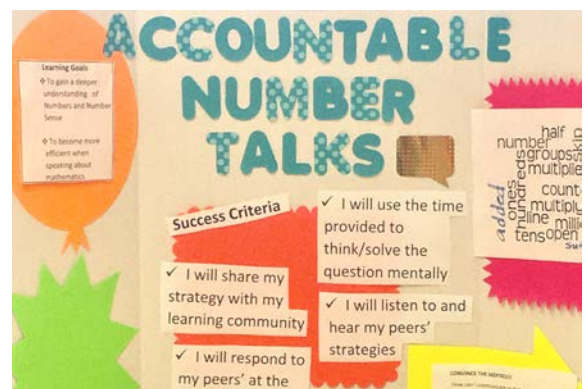
This example is modelled on the work of Hamilton Wentworth teacher Suzana Milinovich. A case study detailing her classroom practice is also provided in this resource beginning on pg. 84.

- The teacher focuses on a fostering an effective math strategy, for example fostering collaborative classroom discourse around mathematics.
- The teacher selects a strategy to encourage communication in the math classroom, for example Number Talks. Other strategies include Gallery Walks, Math Congress, Bansho, etc.).
- The teacher creates a physical space optimal for collaborative whole-class discourse through **Knowledge Building Circles**. For example, in this case, a community table made of a whiteboard was placed on top of rectangular tables in the centre of the room as a space dedicated to collaborative discourse.
- Teachers and students co-design the learning goals and success criteria for Accountable Number Talks to help lay out how classroom discourse will be organized and conducted.



| Learning Goals | Success Criteria |
|--|---|
| To gain deeper understanding of numbers and number sense | I will share my strategy with my learning community |
| To become more efficient when speaking about mathematics | I will respond to my peers at the right time, using scaffolds wherever possible |
| | I will use the time provided to think/solve the question mathematically |
| | I will listen to and hear my peers' strategies |

- The teacher deliberately explains one of the learning goals: “To become more efficient when speaking about mathematics.” She begins by introducing one **KB math scaffold** (sentence stem) — “*I agree with because/I disagree with because.*” The teacher models how to use the scaffold and communicates the importance of using scaffolds when speaking about mathematics. This first scaffold is written down on paper and is laid out in the middle of the table so that it is made visible to the students.



Accountable Number Talk Success Criteria and Learning Goals

- Students collaboratively tackle a math problem by gathering together in a circle around the table. The teacher introduces a math problem and facilitates the discourse (see “*What does a collaborative problem solving session look like?*” on the next page to explore in more detail how these discussions can unfold). The aim is to work towards the gradual release of responsibility for facilitation of the conversation to the students themselves.
- The KB community is at the preliminary stage of discourse as represented by only two scaffolds on the table: “*I agree/disagree with _____’s solution because...*” (see Photo 4). This scaffold helps students to learn to share diverse ideas and to articulate their math thinking. It also helps them to disagree respectfully and to work with ideas that both support and contrast their own — both key capacities for creative work with knowledge. As a next step, students can build off this scaffold and start to frame their ideas and pose questions using key KB Scaffolds “*My theory is*” or “*I still need to understand*”. “*This growth in scaffold use supports the goal and ultimate purpose of Knowledge Building Discourse, which is to move beyond *argumentation* and *idea-sharing* towards actively developing theories, building upon ideas and *creating new knowledge*. Ultimately, KB Discourse is concerned with the questions: **How can we make this better? Are we headed in a promising direction? Are we getting to the heart of the problem?***”
- Over time, the teacher can both introduce new scaffolds to students, and also listen for scaffolds emerging from students’ naturally-occurring dialogue to deepen the discourse (e.g., “*Building onto _____’s idea...*”). The teacher records the new scaffolds and adds them to the table (see Photo 5). At the next Accountable Number Talk/KB Circle, the teacher reintroduces the new scaffold to the students.
- Every day the class reflects on the scaffolds (part of the Accountable Talk success criteria) and the newly added scaffolds.
- After each Accountable Number Talk/KB Circle, students individually reflect on the use of a math scaffold in their Math Journals (e.g., setting a goal to use a specific math scaffold next time, how one was used and how it helped the learning/understanding of the knowledge community, etc.). Students also reflect on and record the mathematical thinking that they shared during the discussion, or the ideas that a peer contributed, in pictures, numbers and/or words.

The **KB Scaffolds** (see pgs. 42-44) represent the kind of talk that helps students actively develop theories, to go beyond opinion and information-sharing to growing ideas, and constructing new knowledge. KB scaffolds represent very powerful epistemic markers — essentially, ways of thinking and knowing — that can help support student engagement in expert-like processes and behaviours, and help grow a culture of knowledge creation within a classroom.

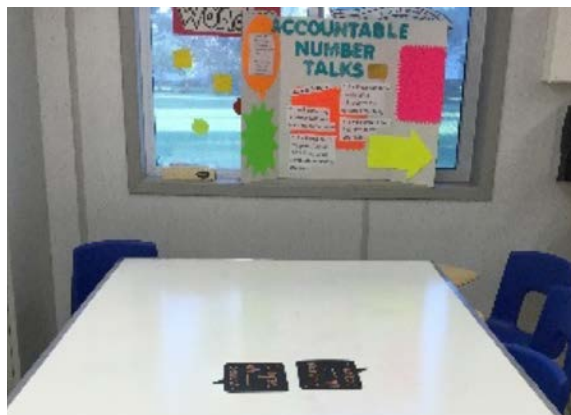


Photo 4. The classroom table where KB Circle / Number Talks take place. At the onset, the table has only two scaffolds.

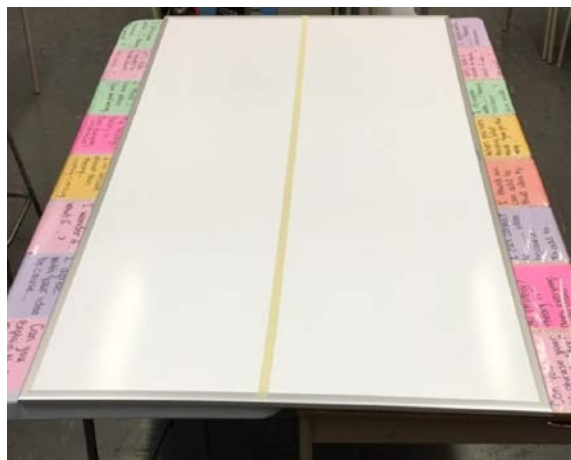


Photo 5. The addition of scaffolds around the table occurs over time as discourse deepens.

WHAT DOES A COLLABORATIVE PROBLEM SOLVING SESSION LOOK LIKE?

This section provides an elaboration on the work described above. More specifically, we narrow down on what a KB approach to tackling an assigned math problem can look like in the context of community Knowledge Building. The focus here is on outlining some practical steps and important teacher moves that take place during the process of collaborative problem solving.

POSSIBLE METHOD OF DELIVERY

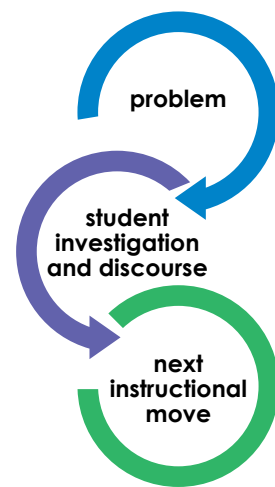
- **A key mathematical strategy that helps bring to life key KB Principles has been selected** (e.g., fostering collaborative KB Discourse in the math classroom) and a plan for implementation has been set (as outlined on the previous page).
- **Teacher introduces a provocation or problem** related to the Big Ideas in the Mathematics curriculum to ignite wondering and questioning. For instance, the question: “What is 20% of a number”? (Overall Expectation #1 in Gr. 5 Number Sense and Numeration).
- **Students are given sufficient independent think time** (approximately 5 minutes) to puzzle over the problem individually (e.g., mental, visible, non-permanent flexible think space).
- **1st KB Circle/Accountable Number Talk:** As a whole group, students are given the opportunity to share their initial thoughts, understandings, misconceptions, and any need for clarifications on the problem (5-10 minutes).
- **Investigations:** Students break out independently or in pairs to work on skills and engage in mathematical processes such as reasoning, problem-solving, theory-building and communicating their mathematical thinking.
- **2nd KB Circle/Accountable Number Talk:** Students come back as a whole group to share their theories, solutions, justifications, reasoning, etc., through the use of KB scaffolds.
- **Reflection/Exit Cards:** Students go back to complete their individual Math Journal entries in which they reflect on their own use of scaffolds and the ideas they discussed, or they can reflect on the ideas others’ contributed.
- **Assessment is ongoing:** The teacher is uncovering the misconceptions and identifying specific learning needs of individual students and the whole group to inform and guide the teachers’ next instructional move.
- **Strategize about the next instructional move:** In which direction do I need to go?

*IF most students have deep or recurring misconceptions, THEN → **Direct teaching to the whole group*** (e.g., deliver a mini-lesson to the whole class).



- *IF most students have a good grasp of the concepts, THEN*
 → **Conduct guided instruction** (e.g., conduct a small group mini-lesson; for instance, take a small group, have a manipulative at the table, and show them concrete examples of the problem).

IF the community grasps the concepts, THEN → **Support further theory development with the class** (plan the next Accountable Number Talk/KB Circle problem to build on the initial problem and to help push thinking further). The teacher reflects and makes links to curriculum expectations from students' theories. For instance, students are understanding fractions and decimals but are not making the connection to money. After a certain period of time, the teacher decides it's time to bring forth this idea to students in order to help students move thinking forward.



This process can be continued and repeated regularly.

INTEGRATING TECHNOLOGY:

Knowledge Forum (KF) can be introduced to students in this process to help make students' thinking visible to the whole community, and to provide another safe space for all students to contribute their ideas. The open, flexible discussion platform and the program's multimedia features allow for differentiated instruction in order to meet the needs of all learners (see pgs. 96-108 to learn more about KF).

Figure 7 depicts a Knowledge Forum "view." The red and blue notes represent student notes. Figure 8 shows a note when opened up. In this view, students are working on their "Decimal Theories". Images taken from classroom work have been uploaded onto the background of the view to support discussion.

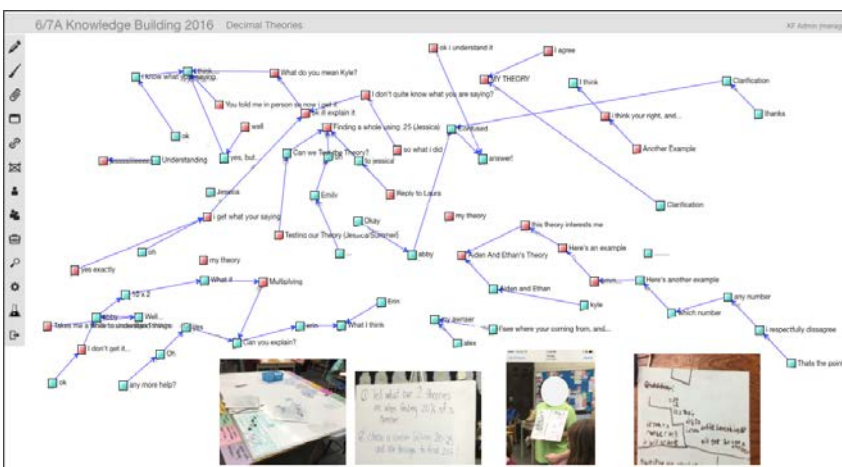


Figure 7. A KF "view" on decimal theories. Student notes are indicated in blue and red squares, with images take from classroom work along the bottom.

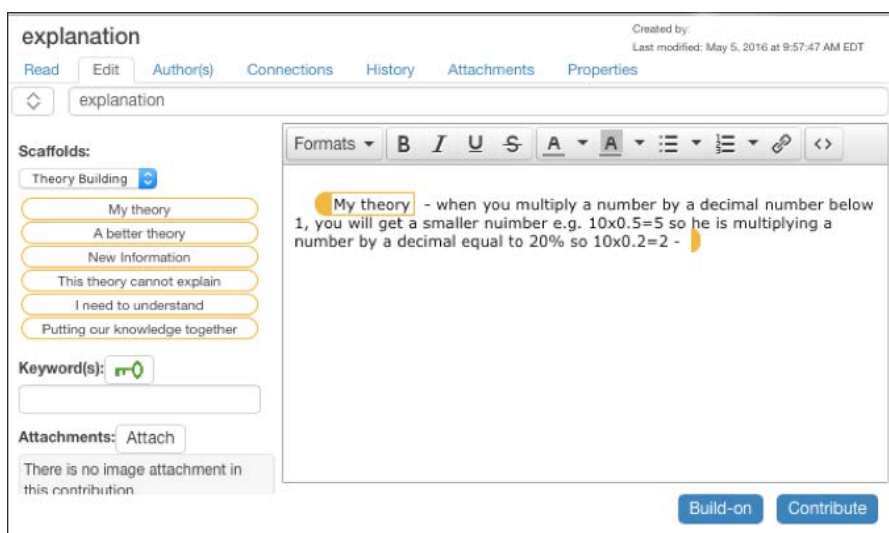


Figure 8. An open KF note. The use of the scaffold support "My theory" used here and framed in yellow, helps to structure student thinking and writing.

WORKING WITH REAL-LIFE ISSUES AND CROSS-CURRICULAR QUESTIONS WHERE MATH CAN BE EMPHASIZED

It can be a challenge to find authentic math problems — things the students actually wonder about or need to deal with in real life. In the natural sciences, for example, students may wonder about many things; **how can teachers help them see the mathematical side of what they wonder about?** For instance, information about life spans of different animal species is sure to raise questions — why do some animals live only weeks, while others live more than a hundred years? Students will generate theories such as ‘larger animals live longer.’ From these notions, *Real Ideas, Authentic Problems* arise as students test their theories, discover that some facts do not fit, and then try to revise and improve their ideas. **Mathematics can play a part in all of this and can be brought to the fore through explicit integration of math strands within broader work.**

In what follows, we outline two examples of how mathematics was brought to the fore as one major component of cross-curricular work as part of Suzana Milinovich’s evolving KB practices in her Grade 6/7 classroom.

EXAMPLE 1: EQUA-CITY!

A Social Studies provocation inspired the Big Question: “*What is Utopia?*”? Building off many areas of study, students began to envision and hope for a future in which equality and inclusiveness would be very visible.

- The students wanted to create their own ideal city, and set to work to design a futuristic city they named Equa-City. They proposed ideas and then created models and individual structures to contribute to Equa-City. Students’ structures had to fit together as a whole, so they had to work collaboratively to make their city plan work. Several KB Circles and investigations took place over the course of this work to help students build off one another’s ideas and work out any issues or problems that were arising in the design and construction of Equa-City.
- Authoritative sources and experts were consulted to help the students plan their city. For example, an artist from the Ontario Arts Council came in to help students design and construct their buildings. After students created their initial city design, a city planner visited the classroom to help students improve their ideas. For instance, discussion with the expert planner helped students realize they did not account for grass and green space, or that they were missing some important public buildings and services, such as a hospital.



Students work on building their Equa-City by engaging in active research, design and collaboration.

- Students also asked the city representative challenging questions such as, “How do you plan for a population that doesn’t exist yet?” Students also uncovered technical problems with their structures, such as discovering that some structures were too tall for their respective locations and had to be rethought and relocated.
- The teacher also involved the students in making cross-curricular connections between mathematics and the other subject areas they were engaging. The Sketchnote graphic (right) represents the teacher’s reflection of the Knowledge Building occurring in her classroom community, and the cross-curricular links that were being made throughout the process.



A Sketchnote graphic depicting cross-curricular links and connections

Highlighting the mathematical side of building the “Equa-City”:

When a vibrant Knowledge Building community is built, **Pervasive Knowledge Building** naturally occurs. In this case, students were very invested in designing and redesigning their city and thinking about social justice and equity. An integral and continual part of this process was working with mathematical ideas and concepts.

- Classroom discussions engaged topics like **population numbers** and **data management**, which have direct links to mathematical concepts.
- The teacher recognized that there were many opportunities to engage students in mathematical thinking and develop critical math skills (reasoning, problem-solving, communicating) within the context of this authentic inquiry work.
- Students engaged in mathematical discourse around important math concepts during KB Circles and group discussion. For example, part of the process of building the city’s structures was translating students’ plans from 2D to 3D. KB Circles were used to help the group decide how to undertake this process successfully and bring their visuals to life. Students engaged important mathematical ideas in **geometry**, **measurement**, and **spatial reasoning**. Moreover, students wanted to ensure equity and education for all in their city, so they devised a plan to take a percentage of baseball ticket sales to fund public education. They worked on **data management issues**, and problems involving **percentages and fractions** as they designed both the architectural, social, and cultural aspects of their city.



Students build 3D models of their designs and structures.

EXAMPLE 2: ENHANCING OUR COMMUNITY!

This example features the work of Waterloo District School Board teacher Rhonda Hergott. The text below is adapted from her blog *Thoughts from the Behind the Desk*. The images below can be found there, as well as links to student work and videos. Access Rhonda's blog here: <https://rhondahergott.wordpress.com>

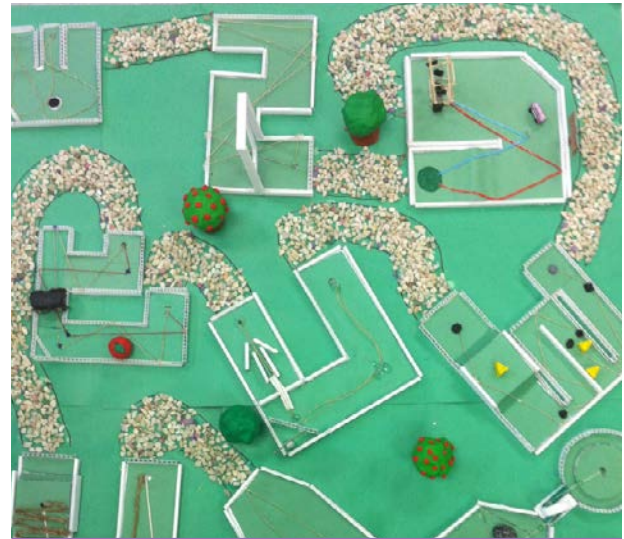
- Students were provoked into learning more about their own small community when the question was posed to them: *"Is our community in need of a mini-golf course?"*
- Students contacted StatsCan to collect demographic information about their community, and discovered how difficult it was to understand and interpret raw data. Students agreed that they needed more information to work from.
- Students decided what information they needed to acquire, and collaboratively designed their own survey. Students also discussed strategies for how they would deliver the survey and decided on methods to access a random sample of community members.
- Infographics to communicate findings was chosen as a useful approach for the project. Students analyzed infographics, created success criteria for their own designs, explored various infographic programs, designed drafts and engaged in peer assessment to improve designs.
- The location of the mini-golf course also had to be determined. Students discussed different options and settled on three possible locations. They then headed out to examine each setting to select the most appropriate option. Students used trundle wheels and measuring tools to assess scale and space and also took into account factors such as lighting and fencing.

“There is no real situation where we would only use one concept in math to solve a problem. Yet in education it seems that is the only way we teach it. Math concepts, independent of one another, disjointed with no purpose other than to complete the 7 questions on page 126 of the textbook. This year my math class is not going to focus on one strand at a time but instead focus on designing, developing and creating a miniature golf course that will represent the small community we live in. The math that will be required to solve this problem will come from all strands and will have a purpose.” — Rhonda Hergott



Students observe, take measurements, and notes during a field trip to a real mini-golf course.

- Students designed mini-golf holes individually. They then undertook field research to learn more about how golf holes are designed, so they organized course. Students also requested and arranged for a local landscape artist to attend the trip and help students plan their own holes, and think about important elements such as accessibility for mobility devices and vehicles.
- Once the mini-golf course was designed, students self-organized into various teams to prepare a presentation for the Apple Butter and Cheese Festival, which, if successful, would result in the class receiving funds to build a transportable version of their golf course. There was a Presentation Team who would create and present the final presentation, a Data Team who would summarize all the data collected and interpreted throughout the project, a Research Team who would determine materials and prices for building a model, a Model Team who would construct a 3D model golf course, and finally, a Documentary Team that would record the whole process ([see their movie here!](#))



A 3D model of the student-designed mini-golf course

Highlighting the mathematical side of designing the mini-golf course:

- Students' work with census data provided wonderful teaching opportunities to engage students in discussions about what a population is in **data management**.
- The teacher also capitalized on the infographics work to have students investigate more closely how images and **numerical representations** help audiences to understand and interpret the information.
- Designing original surveys opened up teaching opportunities for exploring what a **random sample** is and how to obtain one, as well as discussing what the characteristics of a survey are and what makes for a good design.
- The location assessments engaged students in meaningful learning opportunities around **measurement, scale, and space**.
- On the mini-golf course they visited during a field trip, students also explored the **experimental probability** of each hole. They all played one round and kept track of their score. The score cards were then used as data for classroom investigation about whether there is a connection between experimental probability and the par for each hole.

The following case study provides an elaboration of what a KB approach to collaborative problem solving can look like in action. Note the use of **KB Discourse**, **KB Scaffolds**, and **Knowledge Forum** to support the building and advancement of knowledge. (Watch the video series Innovations in Thinking and Learning: Reflections and Lessons - Grade 6 [here](#) or Math in Action [here](#); or, check out the KB Case Studies package at <http://thelearningexchange.ca/wp-content/uploads/2017/04/Knowledge-Building-All-Case-Studies-Accessible.pdf> for this and more math-related case studies).

CASE STUDY (GRADE 6/7): GETTING KNOWLEDGE BUILDING STARTED IN MATHEMATICS

This case study describes Suzana Milinovich's Grade 6/7 class in Hamilton, Ontario. Her class consisted of 25 students, 16 boys and 9 girls. There were 5 children with Special Needs, 3 of whom were working on an Individualized Education Plan with modified expectations in Mathematics. In Suzana's classroom, it was a significant challenge to ignite mathematical conversations among a diverse set of learners in order to advance an entire group's knowledge. Suzana decided to narrow in on setting the conditions for **Knowledge Building Discourse** that would lead to **Democratizing Knowledge** within the group. It was critical for students to understand that all learners in the classroom are relevant contributors to the group's learning, and to have the opportunity to experience this.

KB PROVOCATION:

The majority of students (88%) commenced the year with a negative attitude towards mathematics; an informal survey Suzana asked students to fill out at the onset of the year showed that 85% of the students felt that they exhibited no strengths in the entire subject area. Suzana identified this as her problem of practice and began to embark on a professional inquiry that would shift the attitude and learning of mathematics with these students.

“ What was your greatest challenge? Students had deep rooted opinions and beliefs surrounding their individual place in a mathematics classroom...They viewed mathematics as a subject in which they either excelled or struggled ... Statements such as, “I can't do this” and, “This is too hard” echoed in the room daily. A student even dressed up as an “I hate Math” calculator for our Halloween festivities! **”**

STRATEGIES FOR SUSTAINING IDEA IMPROVEMENT:

1. Number Talks!

With the understanding that student discourse is a highly effective principle in learning, Suzana looked for ways to encourage this in her math class. She provided opportunities for students to learn how to effectively collaborate by having better conversations where all students could be accountable. During mathematics, she introduced **Number Talks** (3 to 5 times per week) in which students, without the teacher, were encouraged to share their individual strategies when solving a number problem.

THE PURPOSE OF NUMBER TALKS WAS TO DEEPEN CONCEPTUAL KNOWLEDGE OF NUMBERS AND NUMBER SENSE, AND TO INTENTIONALLY CREATE A KNOWLEDGE BUILDING CULTURE BY TEACHING EFFECTIVE KNOWLEDGE BUILDING DISCOURSE IN MATHEMATICS.

When sharing during Number Talks, students were encouraged to explain their thinking as though they were trying to convince a room full of skeptics. As students discussed, Suzana simply sketched/recorded responses. **Simultaneously, students were encouraged, as listeners, to become skeptics of their peers' strategy and respectfully question one another's ideas in order to build critical thinking skills.** Suzana would pose questions such as:

- "Can someone re-phrase ____'s strategy?"
- "Can anyone build on ____'s theory?"
- "Would anyone like to ask ____ a question about their thinking?"

Other Important Elements of Number Talks:

- **Learning Goals and Success Criteria** were clearly communicated, re-visited and articulated at the start of each Number Talk Session (see Photo 6).
- **KB Scaffolds:** All Knowledge Builders (students, teacher) model/use KB scaffolds during each discussion.
- **Reflection and Self-Assessment:** Students were encouraged to reflect on the key KB Scaffolds that they used and were comfortable with. Students reflected on the use of a scaffold in their math journals (e.g., they set a goal to use a specific scaffold next time; explained how they used a scaffold and how it helped the learning/understanding of the knowledge community; etc.)

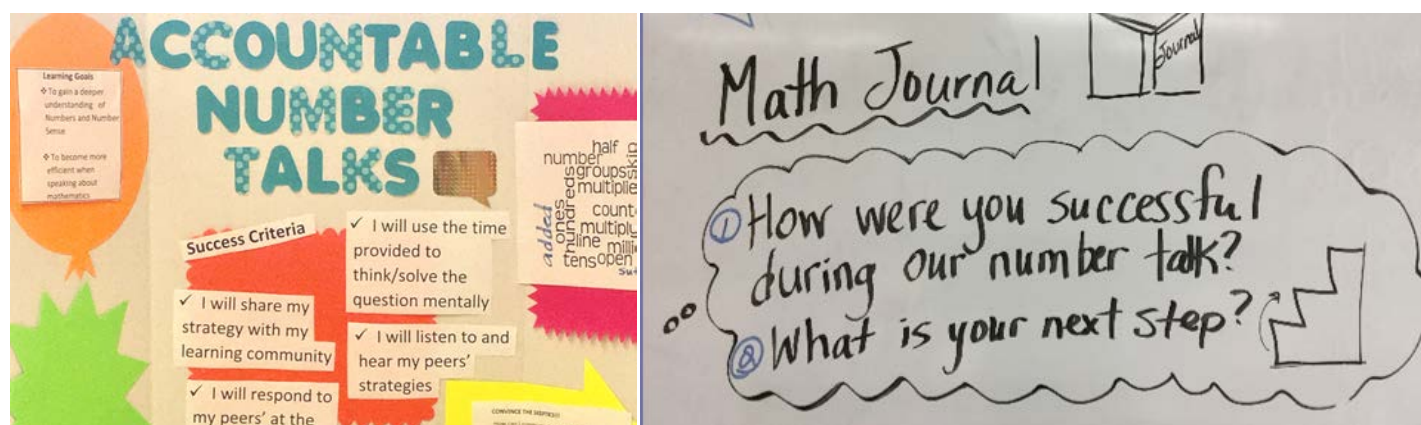
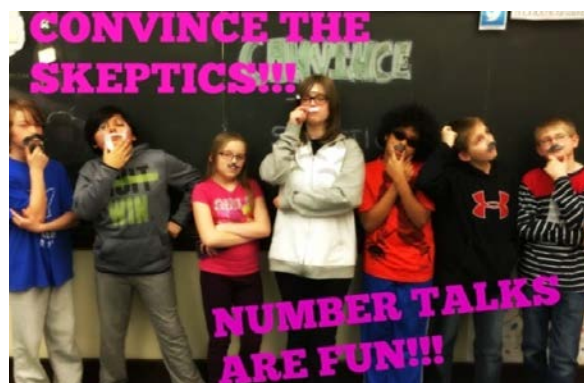


Photo 6. The Accountable Number Talks Success Criteria and Learning Goals (left). Math Journal prompts (right).

2. Creating a Non-Threatening Classroom Environment

Creating a safe culture in which students would feel open to share and address problems with one another was something Suzana identified as a need for the group. She took some time to help students better understand the role of a skeptic in order to help foster citizenship skills in the learning environment. This included dressing up as a skeptic, posing for a photo shoot, creating dramatic role play scenarios, and reflecting on these experiences during a **KB Circle**.



Students dress up as "skeptics" as part of the learning taking place around community-building and citizenship skills in Number Talks.

Suzana provided a deep integration of Character Education in the learning community throughout all subject areas studied. The group of students became the leaders of the Positive School-Wide Culture Initiative, as they created the hashtag #choosekindWHB with student voice concurrently deepening their individual knowledge of specific traits, such as Respect, Optimism, Compassion, and Kindness.

As the culture grew stronger, the number of student contributions to the group discussions increased. As accountable Number Talks/KB Circles progressed, Suzana documented and summarized each valuable student contribution and posted them to a visual conversation bulletin board about 3 to 5 times a week.



Visual conversation bulletin board showing individual student contributions.

3. Democratizing Knowledge: The T.O.G.A. Table!

With anticipation of developing a collaborative learning space while transforming the environment, Suzana placed a whiteboard on top of a double table positioned at the centre of the classroom. Students gathered around this central table to share, reflect, explore, and create ideas during their Number Talks/KB Circles. Suzana identified the success and significance of this new space, which served as the Number Talk/KB Circle anchor area. Suzana encouraged the class to develop a name for it. The students coined the name T.O.G.A. (Table of Great Achievement). This marked a memorable moment during math class, as the students felt a sense of connectedness as they giggled, and chanted its name alongside their teacher.

Suzana added new KB Scaffolds gradually to the T.O.G.A. table as they arose in the students' discourse. At the initial stages, the discourse of the Knowledge Building Community is supported by only two scaffolds on the T.O.G.A. Table:

"I agree/disagree with ____'s solution because..."

Over time, however, several other scaffolds emerged and naturally became a part of the community members' dialogue. These **scaffolds were written down on coloured paper and pasted along the outside of T.O.G.A.** to create accessible visuals for students. Students became increasingly empowered to contribute to the shared goals of the **Knowledge Building Community** (see Photo 7).

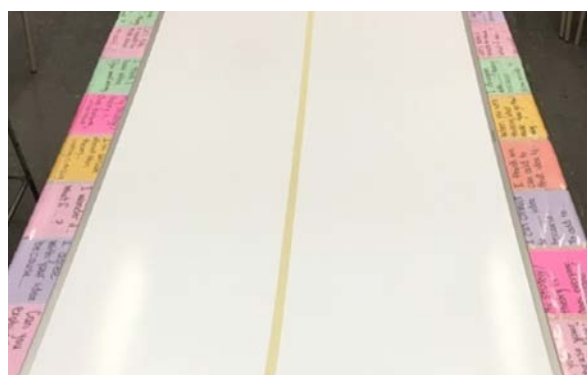


Photo 7. The T.O.G.A. table

THE TEACHER GRADUALLY RELEASES RESPONSIBILITY IN THE DISCOURSE, PROMOTING PEER-TO-PEER MATHEMATICAL INTERACTIONS.

The students were encouraged to reflect on the success of their KB Circles regularly. They clearly identified that everyone’s idea was needed and desired, and **Idea Diversity** occurred naturally during their KB discourse. As students gained the confidence and ability to take pride in contributing to collaborations during a study of fractions, decimals, and percentages, Suzana turned over the class discussion entirely to the students. It was a huge Aha! moment for Suzana, to finally release her responsibility during Knowledge Building Circles. The students had arrived at a destination where they could freely explore big ideas and value one another’s strengths throughout the learning process.

4. Constructive Use of Authoritative Sources

Students were encouraged to use and evaluate source materials to further refine their ideas around decimal theories and principles. With the help of Dr. Monica Resendes, Suzana provided an expert vocabulary word cloud that highlighted key mathematical terms extracted from authoritative sources, such as textbooks and Ontario Curriculum Guides. The students were also provided the opportunity to view a word cloud based on their own vocabulary that was generated on Knowledge Forum (see Figure 9; for more on Knowledge Forum see pgs. 96-108). This was a non-evaluative assessment for students to connect mathematical terms to their ideas, and to deepen their understanding of the mathematical procedures with the vocabulary during investigations and communications. Students used this feedback to further explore and refine their understanding of mathematical concepts that additionally resulted in the use of more mathematical vocabulary when justifying solutions in mathematics.

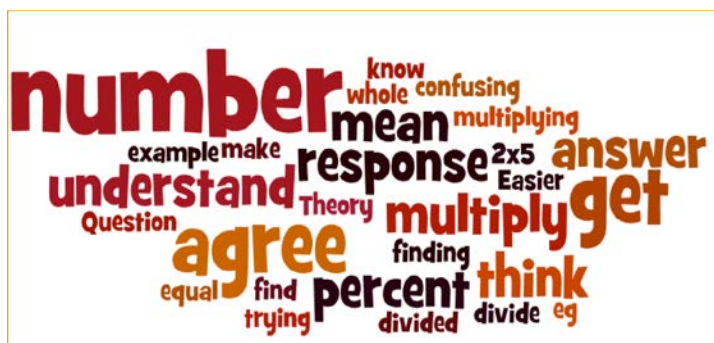
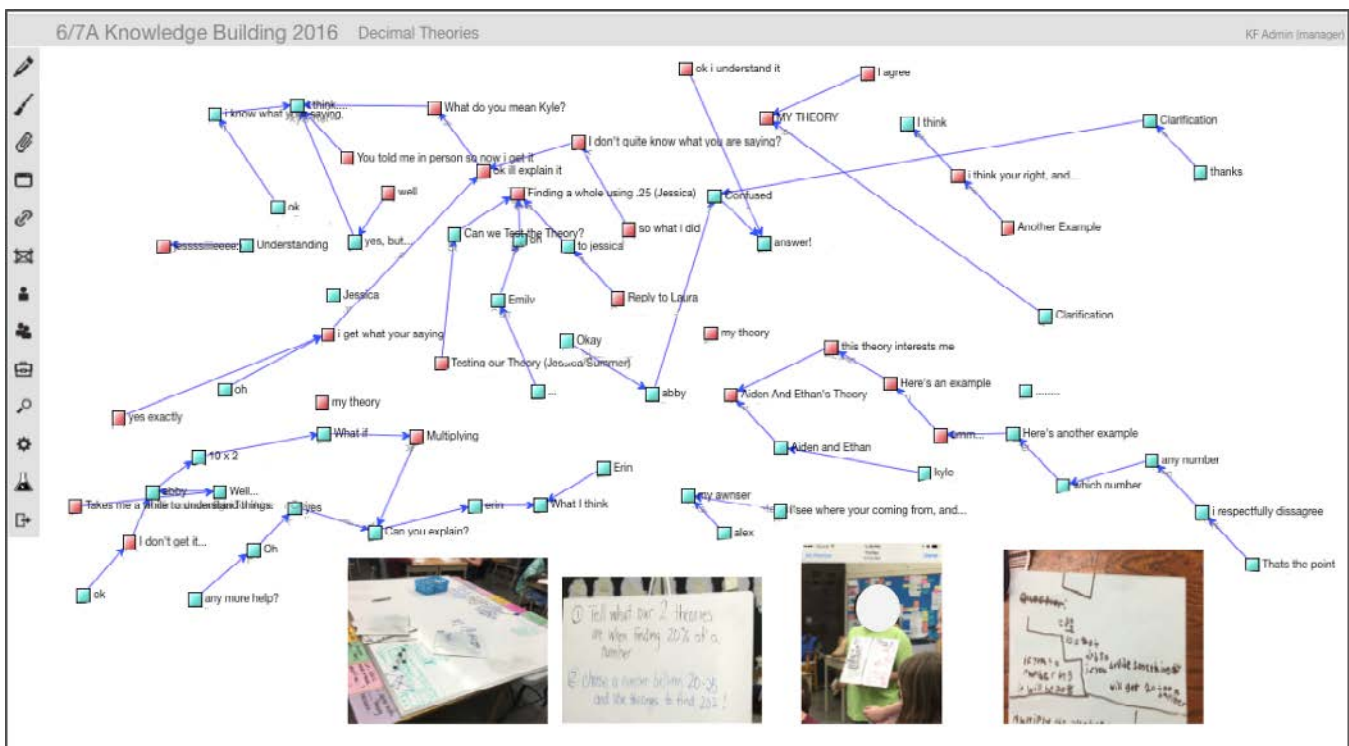


Figure 9. The Knowledge Forum generated word cloud showing student vocabulary (top); the expert word cloud depicting vocabulary from authoritative sources (bottom).

“ What was your “Aha!” moment?
 Releasing the responsibility during Knowledge Building discourse was a great moment. Allowing for students to find their own place in the Knowledge Building community was something I had to learn to be patient with by allowing for it to naturally occur. I had modelled, encouraged, and lead the students to this point of discourse, and didn’t quite let go until another educator, Denis Maika, pushed my thinking by suggesting this idea. The students reveled at the idea of engaging in the KB circles without my presence. As I stepped out, students were able to further explore theories around the mathematics. The transition was seamless, and this proved that the Knowledge Building community was advancing knowledge effectively. ”



Students discussing their “Decimal Theories” on Knowledge Forum. The red and blue squares represent notes that open up when clicked. Red notes have been read, while blue notes are yet to be opened and reviewed. Images from classroom work are lined up along the bottom to spur ideas and thinking.

5. Assessment and Evaluation

Using data collected from assessments such as Student Journal Reflections, and Accountable Number Talk/KB Circle observations, Suzana provided feedback to students on an ongoing basis. She met with guided groups to explicitly teach concepts students were struggling with, as identified in journal entries, observations, and conversations that took place both in Accountable Number Talk/KB Circles and on Knowledge Forum. The assessment tools Suzana used, including an Accountable Number Talks/KB Circle Rubric and an Accountable Number Talk/KB Circle Student Reflections Rubric, can be found on the following page, as well as in the Assessment Exemplars (see pg. 141).

6. Next steps

Suzana’s next step will be to focus on increasing **Democratization of Knowledge** by fostering greater student-to-student connectedness in the KB community. Student achievement will increase in mathematics as she continues to provide opportunities for her students to connect math pervasively. It is expected that KB in mathematics will expand so that it not only involves the single subject with the set particular group of learners. Involving experts, parents, and even students in the greater global community will deepen all stakeholders’ knowledge, understanding, and values in mathematics.

ASSESSMENT TOOLS:

KB Circles/Accountable Number Talks Rubric

| Criteria | Level 1 | Level 2 | Level 3 | Level 4 |
|--|---|---|---|---|
| Student demonstrates knowledge of math content during Number Talks | Student demonstrates little understanding of number concepts when sharing information during Number Talks | Student demonstrates some understanding of number concepts when sharing information during Number Talks | Student demonstrates an understanding of number concepts when sharing information during Number Talks | Student confidently demonstrates an understanding of number concepts when sharing information during Number Talks |
| Student expresses mathematical thinking with clarity and logical organization when communicating in number talks | Student expresses thinking with clarity and organization with limited effectiveness | Student expresses thinking with clarity and organization with some effectiveness | Student expresses thinking with clarity and organization with some effectiveness | Student expresses thinking with clarity and organization with a high degree of effectiveness |
| Student communicates orally to justify a mathematical solution, or express a mathematical argument, using mathematical vocabulary | Student communicates using mathematical vocabulary with limited effectiveness | Student communicates using mathematical vocabulary with some effectiveness | Student communicates using mathematical vocabulary with considerable effectiveness | Student communicates using mathematical vocabulary with a high degree of effectiveness |

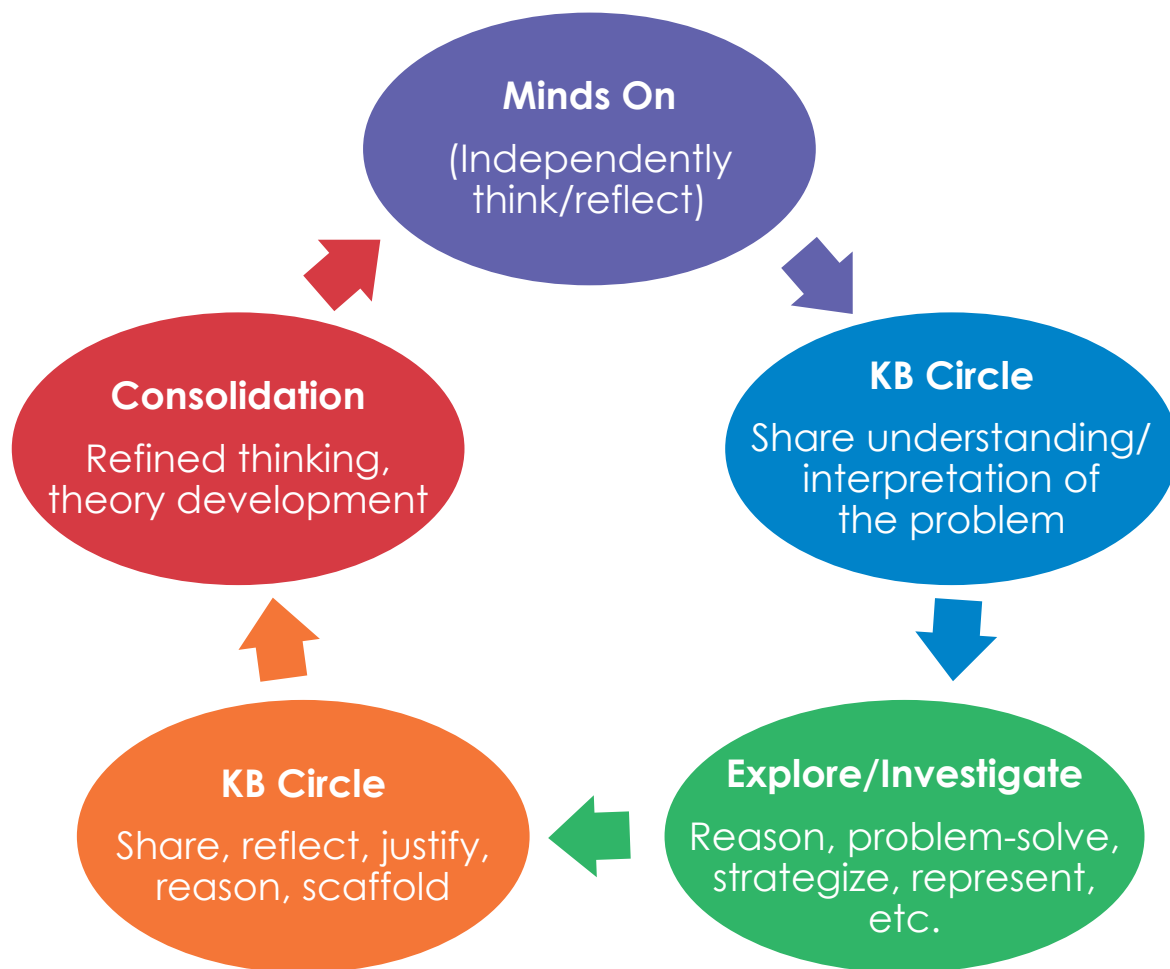
KB Circles/Accountable Number Talks – Student Reflections Rubric

| Criteria | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|--|--|--|
| Student expresses mathematical thinking with clarity and logical organization when communicating about number talks in written form | Student expresses thinking with clarity and organization with limited effectiveness | Student expresses thinking with clarity and organization with some effectiveness | Student expresses thinking with clarity and organization with considerable effectiveness | Student expresses thinking with clarity and organization with a high degree of effectiveness |
| Student communicates in written form to justify a mathematical solution, or express a mathematical argument, using mathematical vocabulary | Student communicates using mathematical vocabulary with limited effectiveness | Student communicates using mathematical vocabulary with some effectiveness | Student communicates using mathematical vocabulary with considerable effectiveness | Student communicates using mathematical vocabulary with a high degree of effectiveness |

RECAP: NUMBER TALKS

Number Talks where teachers intentionally use KB Principles lead to a culture where students:

- hypothesize mathematical ideas
- test and tinker with mathematical concepts
- make mathematically convincing justifications
- listen and respond to mathematical ideas/strategies/theories
- build on others' ideas/strategies/theories
- clarify their understanding
- reflect and apply new learning, ideas/strategies/theories



The case study on the following page illustrates how mathematics was emphasized and integrated within a Knowledge Building study. Note the emphasis on collaborative **KB Discourse**, and **Community Knowledge, Collective Responsibility** throughout the process. (Watch the video series Math in Action [here](#) to see this class in action; or, check out the KB Case Studies package at <http://thelearningexchange.ca/wp-content/uploads/2017/04/Knowledge-Building-All-Case-Studies-Accessible.pdf> for this and more math-related case studies).

CASE STUDY (GRADE 7/8): KNOWLEDGE BUILDING IN THE INTERMEDIATE MATHEMATICS CLASSROOM.

Paula Molloy is an Intermediate Mathematics teacher at John A. Leslie Public School in Scarborough. The following case study describes the experiences and activities that her students participated in while they considered themselves Agents of Change. The Intermediate students explored relevant issues such as: Crime Rates in Toronto, Muslim Discrimination, Genetically Modified Organisms, Teens and Screens, Gender Inequality, Poverty in Toronto, The Consequences of Drinking Bottled Water on the Environment, and more **through the strand of Data Management and the framework of Knowledge Building.**

INTRODUCTION

Having a background in Early Childhood Education, I have spent many years observing children and how they acquire knowledge. Culturally, we seem to understand that children learn from their environment and the stimuli that we provide for them. We freely and naturally provide young learners with tools with which to build, create, and problem-solve. We prepare an educational environment that supports open-ended approaches to learning, encourages a variety of problem-solving strategies, and assesses and honours the process of learning.

I have adopted these same practices in my Intermediate mathematics classroom. Not only has this process involved investigations such as building structures with embedded algebraic expressions, or creating picture books that tell a story about the birth of a mathematical concept and the mathematicians behind the concept, but we extend also our sense of wonder into inquiry projects that make connections beyond the classroom and into the global community.

STARTING WITH THE KB PRINCIPLE(S):

- Real Ideas, Authentic Problems
- Epistemic Agency
- Community Knowledge, Collective Responsibility

KB Provocation: Real Ideas, Authentic Problems

As students mature they continue to make sense of their world. The Intermediate student is a curious learner who is able to receive and synthesize information, and form and share their own perspectives. As a class, we discussed current events and global issues that impacted their lives. The provocation started with a discussion around the election process in the United States and Donald Trump's perspectives on Muslims and immigration. Conversations were filled with emotion and personal narratives, as connections were made and opinions shared.

Students were asked to select an issue that not only provoked emotion, but one that they were genuinely interested in learning more about, with the belief that they could better educate themselves to make more informed decisions or even create change for the future. They needed to think about how information was presented to them mathematically. Learning goals and success criteria were collectively constructed and the curriculum expectations were clearly identified.

Real ideas and authentic problems allowed students to acquire relevant knowledge, making sincere and meaningful connections. This not only informs the learning but may inspire and motivate students and give students the skills to challenge and change the world around them.

Epistemic Agency

Students collectively or independently determined the issue that was of importance to them; similarly, they had autonomy in determining their work teams. In establishing a culture of Knowledge Building, it is imperative that teachers lay the foundation of what collaborative communication looks like and sounds like. For example, it was reinforced that we are all learners and that all efforts in moving forward are to be built and expanded on as a collective. Students were reminded that all team members had an equal role to play in establishing the inquiry question and participating in the Knowledge Building process. Further to this, team communications and responsibilities were to be documented in a Communications Book in every class. When conferencing with groups, I would refer to the Communications Book and reference individual contributions and their documented process of how the team was building and developing suggested ideas, as well as them having a greater understanding of their next steps.

Strategies to Sustain Idea Improvement: Community Knowledge, Collective Responsibility

As students worked throughout the inquiry process, they needed to work through the challenge of what it looked like to research data independently and to share and learn from it collectively. For example, students were often referencing data that were presented on charts and graphs. Although graphs may have been collected by different team members, the analysis of information and the conclusions made were collectively accomplished. Team members may have developed their own survey questions but, collectively, they discussed the purpose and quality of those questions before establishing a final survey. Collectively, they made inferences on the results of primary and secondary data. Collectively, they made predictions, based on their data, about the future of their issue. Collectively, they discussed how their generation could play a role in shaping the future of their issue. Students were heard discussing the need for governments to change standards and policies on issues such as increasing penalties for criminals, greater consumer education on genetically modified organisms, the consequences of drinking water from plastic water bottles on the environment, and so on.

Students participated in a practice that required the contributions of all team members with the expectation that all ideas would be validated and collectively refined.

Improvable Ideas

Within the culture of the learning environment, the process of learning is where the growth, development and building takes place. All ideas are valid and must receive recognition. If the team decides that an idea is productive to their overall goal, then the idea must be nurtured in order for it to develop and expand. Upon observation during the inquiry process, I could hear a team with a focus on gender inequality attempting to work through a problem with a comparison that they were making. One of the team members was quietly offering a suggestion that could move the thinking forward, allowing the group to narrow their comparison of data. The team, however, remained focused on their current train of thought and were unresponsive to the student's improvement plan. As an observer and a facilitator, I asked the team to explain their challenge and then I asked them to once again listen to the improvement plan of their peer. It was a learning opportunity that served to not only push their idea forward but also to reinforce that all team members must be heard when sharing ideas and improving upon them.

In terms of the mathematics, for example, groups often experienced difficulty with primary data collection. They were faced with the challenge of attempting to collect accurate and representative data within their own school. The growth was observable as teams worked through and improved their ideas, ensuring that they were asking bias-free questions that allowed the person being surveyed to answer honestly, and sometimes even anonymously, to ensure the most accurate results. Similar discourse took place when faced with the challenge of selecting appropriate graphs to represent particular data. Students improved their ideas through discussions that included the purpose of communication for each graph type.

The use of the Communication Book was also a valuable tool as it documented the process, development and improvement of their initial ideas, and allowed students to reflect on the rich journey that led them to success.

Embedded, Concurrent and Transformative Assessment

During our mathematics inquiry, the assessment was embedded within the process. The process is the learning. I had regular and ongoing communications with individuals and with teams. I anecdotally recorded observations that also included the support and direction that I gave to each team. Students continued to document their process within their Communications Book, paired with occasional progress reports.

Providing feedback throughout the process was critical. It was my role to ensure that students were maintaining a clear focus, asking and researching rich questions, working equitably as a team and referring to the learning goals and success criteria that were collectively established. Throughout this process I was able to push the students' thinking forward. Students were asked to go beyond researching information on their issue and ensure that they were bringing their own informed perspectives to the project. For example, the team that was comparing gender inequality in Canada compared to Pakistan speculated that it was likely that information regarding issues of inequality and abuse perhaps is not reported and that the actual data may indeed be more concerning than is mathematically documented.

The growth and achievements made throughout the process need to be assessed. The process is where the thinking, problem-solving and refinement take place. The product is a result of the process; therefore, the assessment, embedded within the process, and the finished product and presentation, all need to be assessed.

Conclusion

The conclusion of our inquiry included a reflection piece. Students must reflect on their journey and their process of learning. A reflection should highlight their challenges and discuss how challenges were overcome, their surprises, their successes, the knowledge that they built as well as the new curiosities that arose from their inquiry.

With this particular inquiry, a part of the concluding process was actually the birth of a new and thought-provoking journey as students identified the possible future. Based on the actual data within their inquiry projects, students were to make informed predictions about what their issue would look like 10 or 20 years from now, with the realization that they are indeed the Agents of Change. We abstractly placed these supported predictions into a time capsule and acknowledged that the behaviours of their generation would shape not only their own future, but also the future of the next generation. As an educator, reflection is equally as important as we continuously strive to refine our own ideas, take risks, maintain an open mind and provide best practice methods that will further the quality of learning for our students.

KNOWLEDGE FORUM

KNOWLEDGE FORUM: TECHNOLOGY TO SUPPORT CREATIVE WORK WITH IDEAS

Knowledge Forum (KF) is an online environment that supports **Knowledge Building Discourse** and creative work with ideas. In Knowledge Forum, students enter questions, ideas, information, and so on, as multimedia notes into a shared community space. KF notes can include images, videos, and documents. Students can also build-on, annotate, and co-author notes. Knowledge Forum's visual interface gives an overview of a discussion as it is unfolding, making student thinking visible and the process of idea improvement tangible (see Figure 10).

Students' contributions can be organized thematically within views, which are the spaces in which discussion occurs. Views allow for multiple dialogues to take place within the KF community at the same time, and help to give organization to community knowledge (see Figures 11 and 12). Images and drawings can be uploaded onto the background of views, so that students can take charge of their own discussion spaces by re-arranging notes and customizing their views to help organize and express their ideas.

While it is certainly possible to do Knowledge Building without using Knowledge Forum, the technology offers invaluable support and enhancement to the idea improvement process by giving community ideas an infinite space to live and grow, and by offering powerful new ways to assess students' discourse through the use of automated tools and assessments. As an open and ever-evolving space, it supports assessment-for-learning by giving teachers an opportunity to trace students' ideas over time and a chance to see where student research is heading.

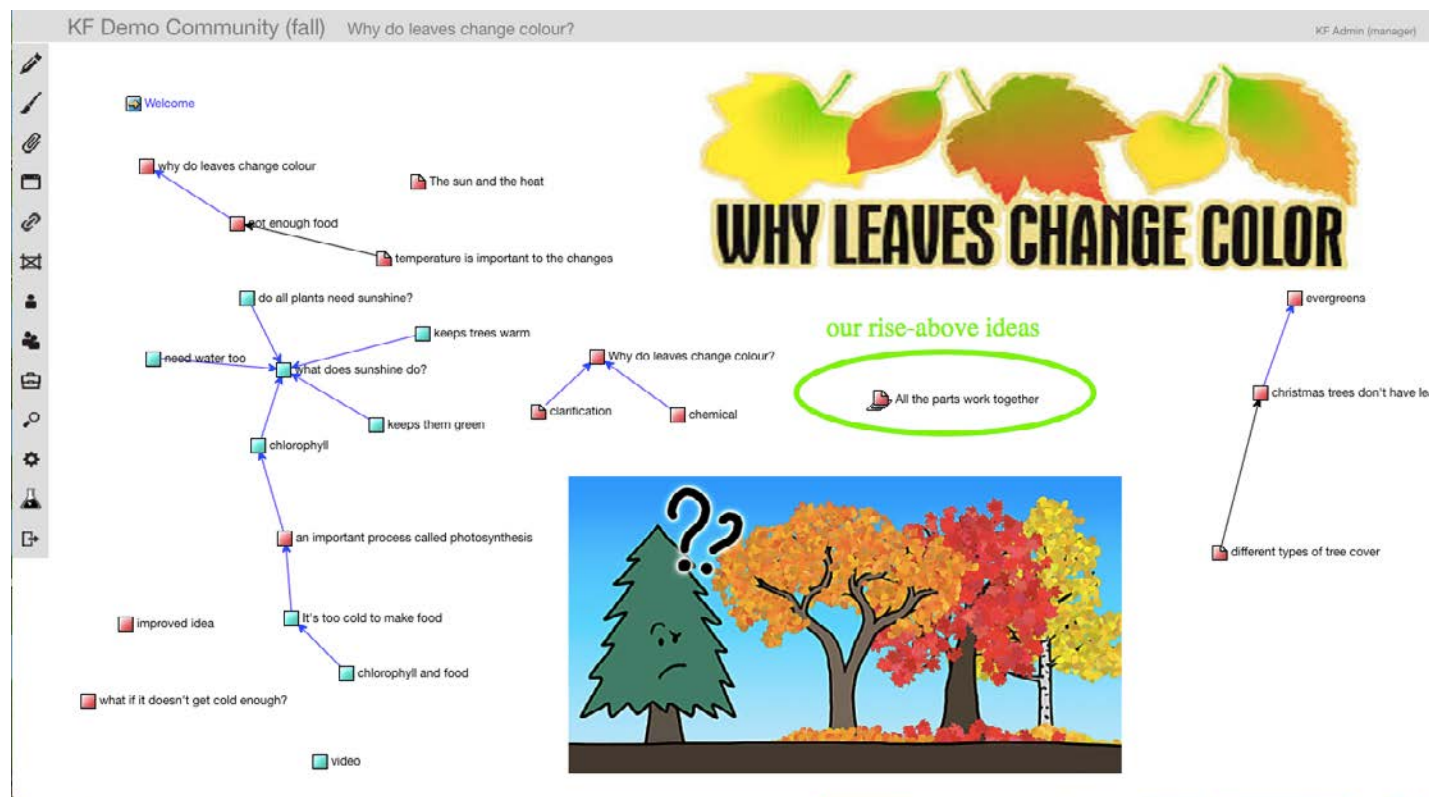


Figure 10. A Knowledge Forum view with build-on threads consisting of student contributions.



Cycles of Nature

New view



The Wood Wide Web?!

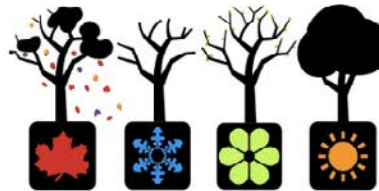
Why do leaves change colour?

student note
Monica Resendes



How do roots work?

Fall Cycle



Our Next Knowledge Advances

Figure 11. A screenshot of a Knowledge Forum homepage or Welcome view, which can act as a kind of 'table of contents' for the various discussions and investigations that are taking place within the community space.

Figure 12. Three of the five Knowledge Forum views within the community, each dedicated to a distinct but related question or area connected to the main theme Exploring Cycles of Nature. The views include The Wood Wide Web?! (above left), Fall Cycle (above right), and "Why do leaves change colour?" (bottom).

BRINGING “COMMUNITY KNOWLEDGE, COLLECTIVE RESPONSIBILITY” TO LIFE

By contributing to a public space, students’ ideas become part of the community’s knowledge capital – ideas become “ours” instead of “mine.” The principle of **Community Knowledge, Collective Responsibility** becomes real as students’ ideas are validated and built on by others, and they take on the task of acknowledging, valuing, and working with everyone else’s ideas. The technology allows the process of idea improvement to become tangible, and unlike the classroom wall, the digital format allows for an infinite amount of space for discussion and growth of ideas. KF also opens up another space in which community discourse can take place, and through which students can voice their thoughts and build onto one another’s contributions. Something we hear repeatedly from students and teachers alike is that students who are shyer or who do not tend to speak up in verbal discussions really open up on Knowledge Forum, as the online platform provides a safe space for them to share their ideas and contribute meaningfully to collective dialogue.



“It was really cool how we just kept building on to each other’s stuff... cuz like we started with one thing, and then people builded onto that, and then people builded onto that, and then just, it’s basically like going through generations”

— Grade 1 RCDSB student talking about why he liked improving ideas on KF



SPECIALLY-DESIGNED KNOWLEDGE BUILDING SUPPORTS

There are special supports embedded within Knowledge Forum to help students engage in Knowledge Building Discourse and Idea Improvement, including the **KF Scaffolds**, **Rise Above Notes**, and **Note Referencing**.

The **KF Scaffolds** are an automated feature in KF that supports the pedagogical tool we have been referring to throughout this resource as the KB Scaffolds. As seen in Figure 13 on the following page, the scaffolds are available right within a KF note, and help students to frame their thinking and writing in powerful ways. All a student needs to do is simply click on these scaffolds and the selected scaffold appears in the student’s note. KF Scaffolds are customizable, so teachers can create their own sets of scaffolds depending on the subject area their students are focusing on. For instance, one could use the Historical Thinking scaffolds (see pg. 43) alongside the Theory-Building set if students are engaging in an historical inquiry, or the Scientific Thinking set if the focus is on science and technology. Teachers can also co-create scaffolds with students to help them engage in deep discourse and theory building, like Suzana did with her students in mathematics (See Getting KB Started in Mathematics in the KB Case Studies package available via [The Learning Exchange](http://thelearningexchange.ca/wp-content/uploads/2017/04/2_5-Getting-KB-Started-in-Mathematics_Accessible.pdf) at http://thelearningexchange.ca/wp-content/uploads/2017/04/2_5-Getting-KB-Started-in-Mathematics_Accessible.pdf). A growing body of research shows the KF scaffolds to be effective Knowledge Building tools for students across Grade levels (e.g., Ma et al. 2015; Resendes et al. 2015;

THE PRACTICE:

Get started with KB Discourse by introducing the Knowledge Building Scaffold. The KB Scaffolds represent the kind of talk that helps students actively develop their opinion and information-sharing to growing ideas and constructing new knowledge represented below are typically referred to as the KB Theory-Building Scaffolds. They represent very powerful "epistemic markers" -- essentially, ways of thinking and how can help support student engagement in expert-like processes and behaviours, an culture of knowledge creation within a classroom. Post them around the classroom and students to use these phrases during group discussions, such as KB Circles (see page 10) will become second nature.

- I wonder...
- I still need to understand...
- My theory is...
- Building onto this idea...
- New information + source...
- This theory does not explain...
- Felling our knowledge together...
- An improved idea...
- We need evidence for...
- We need an experiment to...
- A promising idea...
- Our next steps...
- Another way of looking at it...
- An example...
- An analogy/comparison...



Knowledge Building Gallery / Leading Student Achievement: Networks for Learning

Created by: KF Admin
Last modified: 2/27/2017, 2:58:34 PM

Read Edit Author(s) Connections History Attachments Properties

Please write a title.

Formats B I U S A A [List Icon] [List Icon] [Link Icon] [Double Arrow Icon]

Scaffolds:

- Theory Building
- My theory
- A better theory
- This theory cannot explain
- Putting our knowledge together
- I need to understand
- New Information

Keyword(s): [Search Icon]

Attachments: Attach

There is no image attachment in this contribution.

Contribute

Figure 13. The Knowledge Forum scaffolds embedded within a note. The Theory-Building set is shown here, and includes scaffolds such as “My Theory,” “I Need to Understand,” and “Our Improved Theory.”

RISE ABOVE NOTES:

Rise Above notes play a crucial role in idea improvement. A Rise Above idea is not about selecting between opposing ideas or creating a compromised idea that gives up some of the power of those ideas that play into it; rather, Rise Above ideas are about “creat[ing] a new idea that preserves the value of the competing ideas while ‘rising above’ their incompatibilities” (Scardamalia, 2004, p. 7).

All the parts work together

Created by: KF Admin
Last modified: February 11, 2016 at 9:58 AM EST

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Riseabove View:

Our improved theory - It's not leaves and trees that work it's the roots and leaves that work together to make leaves green. The roots make the chlorophyll, it goes up the tree trunk, and goes into the leaf.

Source of information: - We learned from circle time -

```

    graph TD
      A[Why do leaves change colour?] --> B[clarification]
      A --> C[it's too cold to make food]
      B --> D[chemical]
      D --> E[Chlorophyll leaks]
      E --> F[improved idea]
    
```

Build on Contribute

Figure 14. A Rise Above note. On the left, students have created an improved theory: “it’s not leaves and trees that work it’s the roots and leaves that work together to make leaves green. The roots make chlorophyll, it goes up the tree trunk, and goes into the leaf.” They cite their source of information as KB Circle time. On the right, community contributions that played a role in helping develop this new understanding are displayed.

Creating a Rise Above note helps to take community knowledge to the next level. A Rise Above note can be created as a community or by an individual student. Rise Above notes include a feature that allows students to gather certain existing notes that played a role in contributing to the knowledge advance and include them within the note itself (see Figure 14, previous page). Rise Above notes are represented on a KF view by means of a slightly altered contribution icon, which makes them easily recognizable.

REFERENCE FEATURE:

The reference feature allows students to work actively with each other's ideas and contributions on KF. Students can select and copy any piece of another person's note, and then paste it into their note. The program automatically generates the appropriate citation, including a link to the referenced note and the name of the note's author. Cited text shows up in italics (see Figure 15).

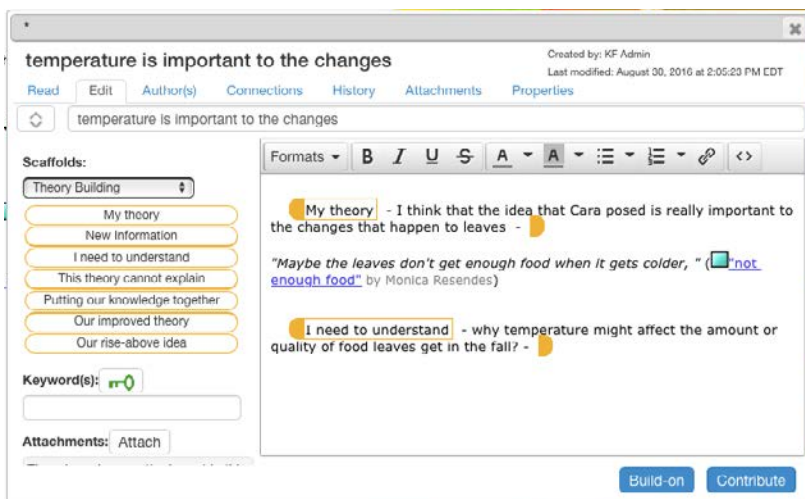


Figure 15. A note with a reference to other community member's note shown in italics.

HOW DO I GET STARTED WITH KF?

There are many ways in which to introduce or integrate KF into your classroom work. To give you some inspiration for how to take step one, we've provided a few different accounts of how to integrate the use of KF into classroom practice. These approaches can be adapted and utilized in both elementary and secondary classrooms. Note: there are also a number of case studies that focus on the use of KF in the classroom. For instance, check out how Nancy Raynor utilized KF as a teacher-librarian with her students (see Knowledge Building Using Knowledge Forum: A Teacher-Librarian's Story in the KB Case Studies package available via [The Learning Exchange](http://thelearningexchange.ca/wp-content/uploads/2017/04/2_4-Grade-6-KB-Using-Knowledge-Forum-A-Teacher-Librarian-Story_Accessible.pdf) at http://thelearningexchange.ca/wp-content/uploads/2017/04/2_4-Grade-6-KB-Using-Knowledge-Forum-A-Teacher-Librarian-Story_Accessible.pdf). Or, see how Angela Hoffman and Mubina Panju used KF with their Grade 1 and SK classes in the case study Knowledge Building in Primary: What Makes a Community? also at http://thelearningexchange.ca/wp-content/uploads/2017/04/1_2-KB-in-Primary_What-Makes-a-Community_AODA.pdf also on [The Learning Exchange](http://thelearningexchange.ca).

Knowledge Forum YouTube Tutorials

Check out the series of KF tutorials on YouTube (3-5 mins. each). These mini-tutorials provide a review of the program's various features and tools, starting with the most basic features and continuing to explore more advanced tools and functions. You'll be ready to start using Knowledge Forum after the first tutorial!



Knowledge Forum Youtube Tutorials

<https://www.youtube.com/playlist?list=PLNdWjAw9WQK0keMvP4YBCQxmlIzXAYqnK>

1. START WITH KF RIGHT AWAY AS PART OF THE KB PROVOCATION.

Glenn Wagner, Secondary School teacher, UGDSB, outlines his approach to using KF in his classrooms:

1. Identify the curriculum strand, theme or subject area to be explored.
2. KB provocation: For example, show students a short video from a reputable source such as *ASAP! Science* to stimulate students' ideas and questions.
3. Have students note any questions or ideas the video provokes.
4. Share questions and ideas as a class.
5. Organize students into small groups. As a group, they list all of their questions and ideas together. Next, they evaluate their questions to select one or two of the most promising questions (for more on "*promisingness*" see pg. 38). "Promising" in Knowledge Building work basically means something that is worth spending more time on. Promising questions are deep and rich, engage the how and why of a problem, and are not easily Google-able! For instance, whereas the question "How old is the universe?" can be easily answered, the question "How do scientists know how old the universe is?" is promising in that it can be explored in great depth and can give rise to many other rich questions and avenues of inquiry.
6. Share all of the most promising ideas as a class. Students self-organize into small groups (4-6) according to the question they are most interested in exploring.
7. The teacher sets up the Knowledge Forum space so that students can explore their promising questions. Each question gets its own KF view. The question is written and put up on the background of the view (see Figure 16 on next page). Students can create subsequent views if they find it necessary. Small groups can work in their own views, but can also visit and contribute to other groups' views so that knowledge can be shared and developed across the whole class, with no barriers. Also, the teacher sets up a Welcome page to list all of the different views. Setting up a welcome page helps to organize a KF space, which can get quite populated with views and contributions. It can also help orient students into the space and help them navigate their KF world quickly and easily.
8. Students spend the next few weeks researching and developing their theories on Knowledge Forum in their group. One rule of thumb for work on KF – "Work a question, leave a question!" The teacher provides mentoring and monitoring.
9. Students engage in two forms of summative assessment. i) They produce an individual culminating assignment in the form of an **E-Portfolio** (see pgs. 122-125, 148-153) for more on this assessment practice) in which they demonstrate their deepest understandings and where they went the farthest with their ideas. ii) In the small groups they have been working in, students engage in a **Summative KB Circle** (see pg. 122) in which they are required to verbally communicate, as fluently as possible, the knowledge they have gained and tell the story of how their ideas have improved.

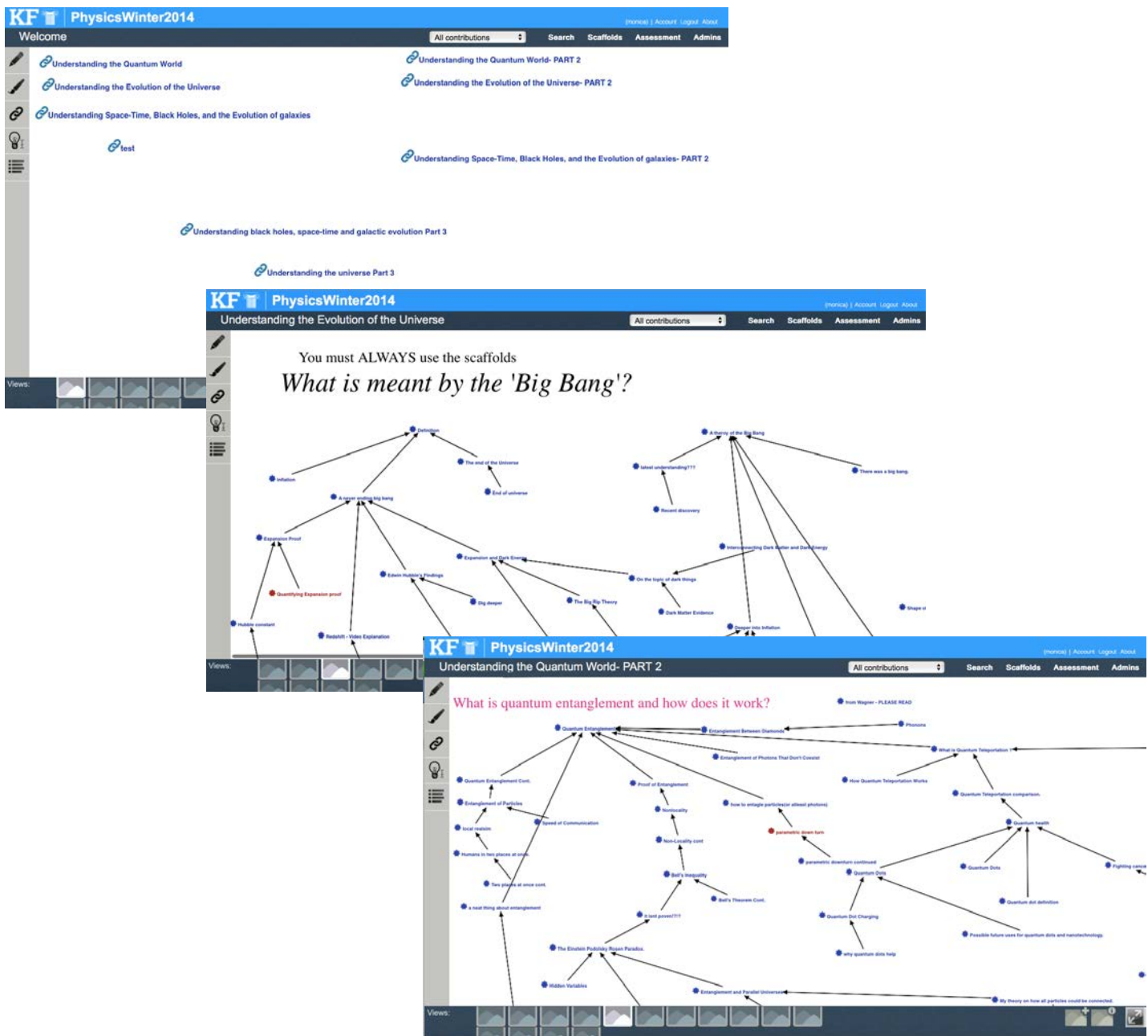
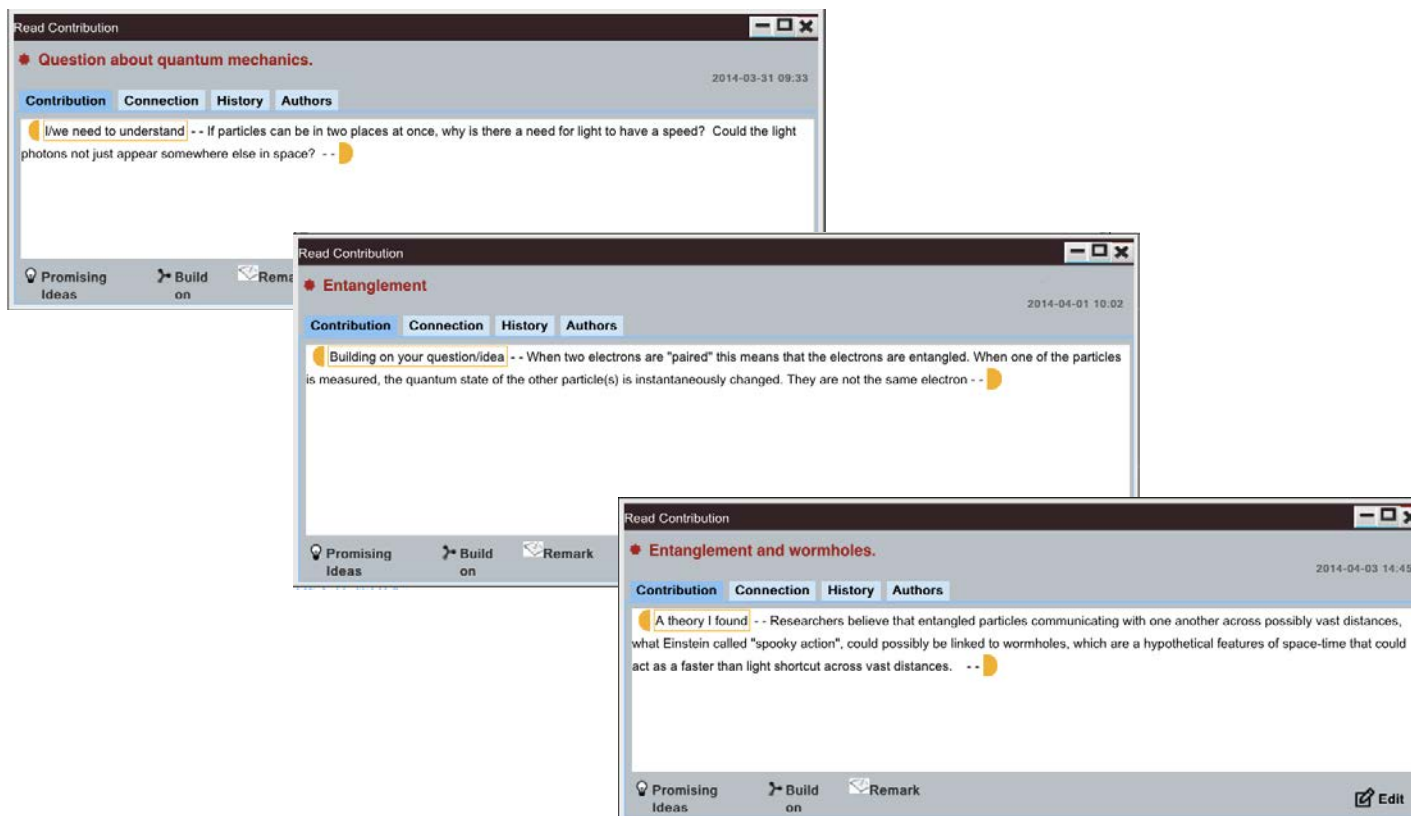


Figure 16. The top image shows a KF Welcome view for Glenn Wagner’s class. This view lists all of the other views that have been created in this KF community, such as “Understanding the Quantum World,” in the form of view links (represented by the chain link icons). The Welcome view is the place that students will automatically land on when logging onto KF. The tabs that run along the bottom of the screen also represent all the different views that have been created in this community, and provide another way of navigating through the community space. **The screenshots at the bottom left and right** represent two of the other views in this KF Community that focus on the big questions that students decided they wanted to explore: “What is meant by the Big Bang?” and “What is quantum entanglement and how does it work?”.



Samples of student discourse demonstrating varied KF Scaffold use.

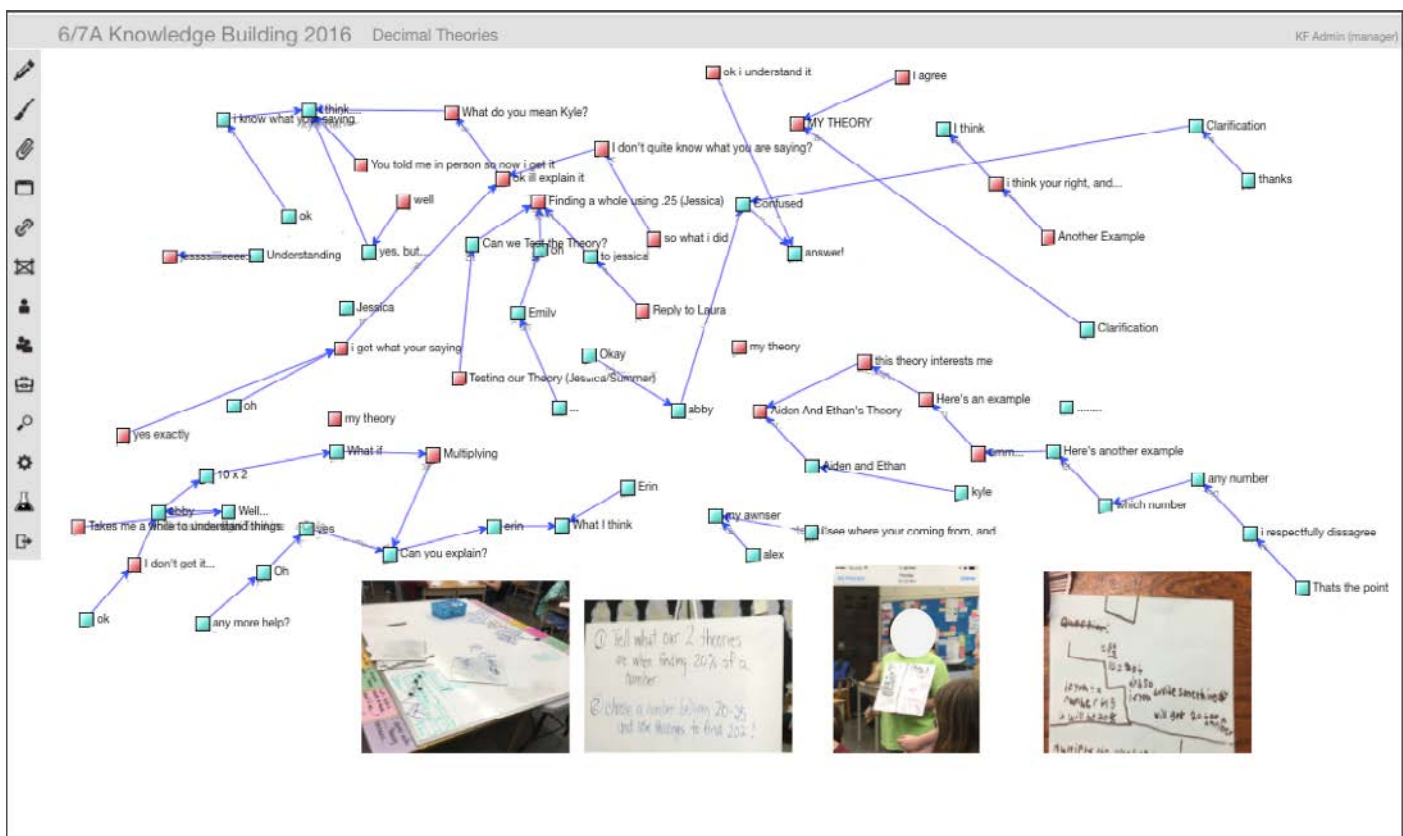
2. PAIR KNOWLEDGE FORUM WITH KB CIRCLES

There is a great dynamic that can happen with ideas when online and offline dialogue are paired together on a regular basis. For instance, there are always those students who tend to be quieter in KB Circles or who may speak but do not go so far as to challenge another’s idea or introduce an “out of the box” idea. However, giving students the opportunity to go onto Knowledge Forum to engage in free discussion directly after a KB Circle allows them to get the ideas and thoughts that are fresh in their minds from the face-to-face talk out into the collective space. Likewise, students who need more time to think and ruminate about their ideas before making them public have the time do so. Oftentimes, contributions come from quieter or shyer students, those who would otherwise never have expressed their ideas. Many times we’ve heard from both teachers and students alike — “I never thought this student had so many unique ideas!”

This tactic also supports differentiated instruction, enabling opportunities for engagement for students with different learning styles. Auditory learners could benefit from group discussion, while visual learners can benefit from the text and visual features on Knowledge Forum. Sometimes, an artifact, object, or experiment can be the focus of a KB Circle, which can offer an opportunity for more tactile or kinesthetic learners to engage more easily.

- In a primary classroom, there are approximately 26 students and only one third as many computers. Twice a week, the class has their KB talk periods. On day one, half of the class engages in KB Circles that are about 25 minutes long. Immediately following the KB Circle, these students go onto Knowledge Forum for another 20-25 minutes until lunch. They pair

- up two to a computer and take turns logging on and contributing a note. The other half of the students go to the library to do research and read with the librarian, who helps them with their KB work. Students also engage in other kinds of knowledge work as a whole class — going on field trips, taking Nature Walks, engaging in read-alouds, and so on. KB talk time, both face-to-face and on Knowledge Forum, are deeply integrated into the daily work.
- In Suzana Milinovich’s Grade 6 math class, students gather together at the T.O.G.A. table (the Table of Great Achievement) for their daily KB Circle Number Talks. A variety of KB Scaffolds, many co-created by students and focused on math, are written on coloured paper and are posted around the table. Students are invited to write on the whiteboard-covered table, or use their own mini whiteboards to jot down ideas. Suzana poses a question for students to puzzle over together (e.g., “How do we get 20% of a number?”). Students explore their initial ideas and theories together for about 20 minutes. Then they break off into small groups for approximately 15 minutes and use a variety of media (paper, tablets, whiteboards) to generate more ideas and work out their problem-solving strategies. Finally, everyone comes back together for another 15 minutes or so to share their ideas and tactics. In regular intervals after the talks, students are invited to go onto Knowledge Forum to further explore the ideas they shared as a group. Photos from the KB Circle work are sometimes posted up on the KF views, and the KB Scaffolds that frame the T.O.G.A. table are also programmed in the KF notes using the custom Scaffold tool (for more information, see *Getting KB Started in Mathematics*, pgs. 84-88).



A KF view dedicated to exploring students’ “Decimal Theories.”

3. START WITH KB WALLS, WORK TOWARDS KF

As illustrated on page 50-54, KF can also be integrated in the KB work after students have generated their questions and spent some time exploring their theories using a KB Wall. Creating KB Walls with students gives them practice using the KB Scaffolds and contributing their ideas to a public space before engaging in the same activities online, using KF. The image below shows the KF community that Elaine Heaver's Grade 6 students worked in once they moved into this digital space. Elaine included a Welcome page (see Figure 17) to help orient students and, with the help of students, created views (represented on the interface by the tabs running along the bottom of the screen) to correspond to each of the main questions that had arisen during the KB work, such as "What happens to sound in space?", and "How does space exploration affect our lives?" The infinite space afforded by KF allowed the students to keep adding views to give room for discussion as needed, without losing the important ideas and knowledge they were generating from the onset of the study.



Figure 17. The Welcome view for the Grade 6 KF community exploring astronomy and space exploration.

A SNEAK PEAK AT KNOWLEDGE FORUM'S COMING ASSESSMENT TOOLS

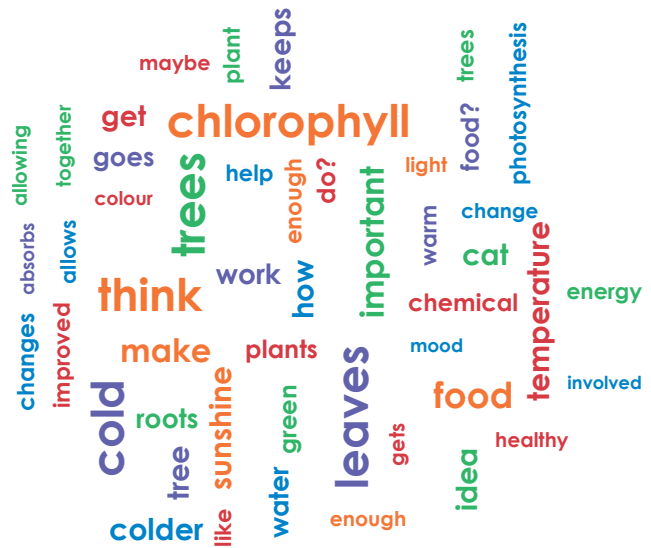
There are a variety of assessment tools being developed for Knowledge Forum that are specifically designed to support Knowledge Building work. In Knowledge Building, group-level assessment is critical for helping the community understand its own strengths and weaknesses, and evaluate how best to move forward. At the same time, a teacher is responsible for reporting on individual students' progress and understanding. For this reason, KF's powerful assessments tools can be applied to both the individual and the group level. Likewise, all of the tools are designed to be used by both teachers and students. They are geared to help a KB community see the progress of their idea development, reflect on important aspects of their community discourse, get an overview of meaningful community dynamics and interactions, and help them evaluate how to best move forward. For example, tools are being designed so that students can get a sense of how they're progressing as an individual but, more importantly, to understand and see concretely: **"How am I helping to advance the community's knowledge?"** We describe the basic suite of KF assessment tools under development below:

THE CONTRIBUTION TOOL

With this tool, teachers can search individual students' online activity to get a quick and comprehensive overview of the quality and quantity of a student's contributions and participation patterns to collective dialogue. The Contribution Tool provides information in the form of a simple bar graph on the following measures: number of notes read; notes written; build-on notes created; notes edited; notes referenced, and notes cited. Such information helps the teacher direct attention to students who may need more support or instruction, and helps them identify barriers preventing students from participating fully in the Knowledge Building community. Similarly, students' notes are displayed in an easy-to-read list which allows the teacher to skim over notes and get a sense of the overall quality of students' contributions. Are they using the KF Scaffolds in their notes? If so, which ones? What is the quality level of their contributions? Are they using key terms and vocabulary? Teachers can use this tool immediately after each KF session the students have, or on a timed basis (weekly, biweekly, monthly). Likewise, students can also make valuable use of the feature by looking up their own contribution profile and evaluating their own participation patterns. This activity can encourage self-reflection and promote greater awareness of students' own engagement and contributions to community work. Pair KF contribution self-evaluations with other student-centred assessment tools such as the **KB Circle Rubrics** and **Self-Evaluations** (pg. 116, 139-141), or the **My Self-Assessment Log** (see pgs. 118-119, 145).

THE WORD CLOUD TOOL

With the click of a button, you and your students can get an easy-to-read visual of the most frequently used terms in the group dialogue. Are your students using key terms or engaging with important concepts? Reflecting on the vocabulary makeup of group discourse can bring to light both what concepts are popular and what ideas might remain missing or neglected in the group dialogue. Group reflection on the Word Cloud can also help remind and encourage students to be engaging with key vocabulary in their contributions.



The Word Cloud Tool frequently used terms in students' KF discourse on the view "Why do leaves change colour?"

THE SCAFFOLD TRACKER TOOL

Research tells us that the more diverse the dialogue, the more likely it is to reflect participants' knowledge advancement and deepening understanding. The Scaffold Tracker tool can be used to assess individual student's contribution makeup and engagement patterns (What kinds of contributions does this student typically make? Are they engaging with the same kinds of scaffolds over and over or are they expanding their repertoire? Are they using higher-level scaffolds in their contributions, such as "Putting our Knowledge Together" or "An Improved Theory"?). Students can use the tool themselves to understand the different ways that they are contributing to the group discussion. The tool can also facilitate group evaluation. For example, setting the tool to explore the community's scaffold use (rather than an individual student's scaffold use) will give a simple overview of the contribution diversity in the collective discourse. Projecting the Scaffold Tracker bar graph on the wall and exploring the graph with students can inspire a rich and reflective conversation about the state of the community's discourse and knowledge. For instance, a graph might reflect many "My Theories" but not a single "Putting our Knowledge Together" or "Our Improved Theory." Students can ask themselves: "So, do we think we are building onto our theories or just posing new and different ones?" "What do we think about the low number of "Important Information + Source" entries?" Students might come to the consensus that they have a great diversity of ideas and it is time to set to work to improve on them by consulting sources, gathering new information, doing experiments, etc. This kind of communal reflection and decision making helps foster student agency, collective responsibility and spur on the process of idea improvement in an organic and meaningful way.

THE VOCABULARY GROWTH TOOL

Looking at the growth of vocabulary relative to outside measures or benchmarks gives the teacher a good indication of whether the students are learning and using key disciplinary concepts. Information about the complexity and quality of children's notes can also give the teacher clear direction as to the type of guidance or instruction the class may need. All of the tools support the teacher in planning in a way that is responsive to the students' evolving needs (see Teplov, Donahue, Scardamalia, & Philips, 2007).

THE PROMISING IDEAS TOOL

The Promising Ideas tool (Chen, Scardamalia, Resendes, Chuy, & Bereiter, 2012) allows students to select promising ideas from their own and other's notes so that they can be easily searched, called upon and explored further. Students can select any part of the note that they believe represents a promising idea, from a single phrase to whole sentences. Selected ideas can be tagged and can also be ordered from most to least promising, based on number of selections of the same idea. The selected ideas can be shown in a list, with the most frequently selected ideas at the top and the least popular ideas near the bottom. Observing this list as a community can serve as a basis for group discussion of next steps — which ideas do we want to move forward with? Selected promising ideas can also be exported to new views to enable more space for growing and developing those ideas. A simple procedure for using the tool can be to have students make individual promisingness selections, and then come back as a group to view the aggregated list and discuss them. The community can then choose 3-5 ideas to work with, and export them to new views, with the knowledge that these new views will be their new community workspaces. This process can be repeated as the work advances to sustain idea advancement. Research shows that students as young as Grade 3 can participate and benefit from this process by making significant knowledge gains (Chen, 2016; Chen et al., 2012).

ASSESSMENT & EVALUATION

ASSESSMENT AND EVALUATION IN KNOWLEDGE BUILDING

Knowledge Building classrooms allow teachers to develop rich and meaningful assessment practices. One of the 12 foundational principles of Knowledge Building is: **Concurrent, Embedded, and Transformative Assessment**. This principle can be understood as feedback that enables collective knowledge advances. It is embedded as part of every-day knowledge work and occurs throughout the entire process, not just at the end. Accordingly, Knowledge Building relies heavily on **assessment for and as learning** to help students deepen their understanding and advance group knowledge. In a KB classroom, a teacher relies on multiple and varied forms of assessment and evaluation. Students also play a vital role in assessment practices and are continually contributing to their own evaluation. Moreover, because KB relies on group processes and community dynamics, both *individual* and *group* level assessment is critical. In the following pages we'll elaborate briefly on both individual and group assessment tools, and give a range of examples of both formative and summative tools and resources you could use and/or adapt for your own class. Part of this section includes a discussion on Evaluation and Reporting that includes practical tools and activities.

In Knowledge Building, assessment information can come from a variety of sources, including:

- student questions
- individual and group conferencing
- drawings and visuals
- whole class and small group discussions
- demonstrations and performances
- Knowledge Forum contributions and activities
- portfolios and e-portfolios
- peer and self-assessments
- self and group reflections
- written reports
- models and designs
- online assessment tools
- exit tickets
- success criteria and learning goals

THINK ABOUT THE ASSESSMENTS TOOLS AND PRACTICES THAT YOU ARE ALREADY USING. HOW CAN THEY BE APPLIED TO KNOWLEDGE BUILDING WORK?

For instance, if you regularly take anecdotal notes to assess communication skills, consider using this strategy during a KB Circle. Or, have students practise their writing skills by asking them to complete summaries or self-reflections after a KB circle to help them re-engage content and/or increase their awareness of their own contribution patterns and habits. Thinking about which tools can be used to target specific competencies during particular classroom activities and practices can be especially helpful for making assessment and evaluation meaningful and manageable.

Be inspired to innovate!

Teachers are continually innovating and designing new assessment tools and strategies that help them evaluate their students in meaningful ways. On the following page is a gallery of some popular assessment tools and ideas, many of them invented by Knowledge Building teachers, for both formative and summative evaluation of Knowledge Building communities.

THE KNOWLEDGE BUILDING ASSESSMENT INNOVATION GALLERY!

The KB Innovation Gallery features assessment tools and practices from practising KB teachers as well as from wonderful resources such as Natural Curiosity (2011). The tools are divided into Formative, Summative and Group Level sections, though all of these tools can be adopted and adapted to suit your own needs and purposes. For each of these tools, ask yourself: **Could this tool work for me? How could I adapt this tool to suit my class and my students?**

FORMATIVE ASSESSMENT TOOLS

CO-CONSTRUCTING KNOWLEDGE GOALS AND SUCCESS CRITERIA

Knowledge Building students are deeply engaged in assessment and evaluation throughout their work. They are invited to co-construct knowledge goals and success criteria and reflect on their progress on an ongoing basis. One approach to supporting this is to bring the curriculum out to students and introduce them to the Big Ideas at the onset of KB work. Students can formulate questions and wonderings about these Big Ideas and can also participate in co-designing success criteria along with the teacher. Likewise, students' own questions and "I wonders", inspired from engaging KB provocations, can form learning goals in themselves ("*I wonder how rainbows are made?*").

Example:

- At the beginning of a new unit of study, write the Big Ideas (as stated in the curriculum) on the board. For example, two Big Ideas under the Grade 4 Understanding Matter and Energy: Light and Sound are: 1. "Light and sound are forms of energy with specific properties;" 2. "Light is required to see."
- Explore these ideas with the class, and clarify their meaning. What questions and comments do students have about them? Which ideas are they most interested in? How could one go about starting to investigate these questions?
- Write down the major questions and problems of understanding that have emerged related to these Big Ideas: "How does light travel?" "How are light and sound related?" "How do eyes work?" Do this knowing that these may be subject to revision or change as the work proceeds.
- Record the main knowledge goals and post them around the classroom: "We will use various experiments to help develop our ideas and understand how light travels," "We will be able to explain how humans and even other animals can see with their eyes."

Exemplar: "Co-constructed Knowledge Goals" (Grade 5 Understanding Structures and Mechanisms), see pg. 138

ANECDOTALS: STUDENTS' SPOKEN COMMENTS AND IDEAS

A teacher's rich documentation of students' questions and wonderings, their emerging ideas, and developing explanations and theories are the foundation for assessment reporting (Natural Curiosity, pg. 22). There are many opportunities within Knowledge Building work for the teacher to observe and assess student interaction, discourse, and idea development — for instance, during Mini-Conferences, Knowledge Building Circles or when students are engaging in small group discussions.

1. Anecdotal Organizers

Description: A lot of student discourse happens in KB classrooms. Anecdotal organizers can help teachers focus listening and observation to tune into and capture important aspects of students' idea development, including progress made, depth of understanding, or challenges encountered. Organizers can focus on students' ideas, questions, clarity of communication, etc.

Putting Assessment into Practice: Two of the documentation templates below are found in Natural Curiosity (2011, pgs. 27-28), and can be used during these assessment opportunities to help focus documentation on key markers of understanding. The third was created by KB teacher Bev Caswell (watch her describe her assessment practices [here](#) or visit <http://thelearningexchange.ca/projects/knowledge-building/?pcat=999&sess=5>)

Tool 1: Anecdotal Organizer

| Students' Anecdotal Comments | | |
|------------------------------|---------|--------------------------------|
| Date: | | |
| Student Name | Comment | Understanding or Misconception |
| | | |
| | | |
| | | |
| | | |

Found in Natural Curiosity (2011, pg. 23).

Tool 2: Assessing Students' Questions

| Assessment Considerations Arising from... | |
|---|--|
| Name: | Date: |
| ...the content of a student's question | ...the quality of a student's question |
| What does this question tell me about this student's interests and curiosity? | Is this question fact-based in nature? |
| What does this question reveal in terms of gaps in this student's content knowledge? | Does this question represent this student's ability to make connections among ideas? |
| What evidence of existing content knowledge does this student's question reveal? | Does this student tend to ask questions that are fact-based, higher-order in nature, or a combination? |
| Does this question build on recently learned information or experiences, thereby revealing a consolidation of learning? | Has this student shown growth in the kind of questions that he or she asks? |

Found in Natural Curiosity (2011, pg. 28).

Tool 3: Assessing Students' Activities and Progress Chart

| | | |
|--------------|--|--|
| Student name | | |
| | | |
| | | |



“So if you just imagine, you know, a piece of paper and it’s divided into the size of square sticky-notes, and each of those squares has the student’s name on it. So I have about three pieces of legal size paper, with the student’s name and each time that we’re doing inquiry or doing science, you know, I’m taking little notes on what students have done and at the end of the week, that whole chart should be filled. If by chance I notice that there are a couple of children who I’ve not been able to make any notes on, that’s a fault of mine. That means I have let two of my students slip through the cracks that week and I don’t know what they’ve been learning in science. And so sometimes it could be just listening to their conversations together. It might be that I work with one of the research groups and really find out what’s there – whether they’re experimental designs, let me see what you’ve got in the lab books. I’m not making red notes in their lab books. I’ve already told them that those are their notes.” — *Bev Caswell*



2. Mini-Conferences

Description: Mini-conferences take place throughout the course of Knowledge Building work. The teacher develops an understanding of student knowledge and understanding related to key concepts, knowledge goals, and success criteria. Anecdotal notes taken during or just after conferences provide valuable information about students’ strengths and achievements as well as any challenges or gaps in understanding students may be experiencing. The rich discussions between teacher and students allows students to go more deeply into their Knowledge Building and draw meaningful connections between their ideas. They also give insight to the teacher on how students are progressing over time. The Mini-Conference Question Guide on the following page lists possible questions teachers can ask during these conferences:

Tool: Mini-Conference Question Guide

MINI-CONFERENCE QUESTION GUIDE

Student Name: _____

- What is your understanding so far of the knowledge goal or main problem/question?
- How have your initial theories and ideas developed so far?
- How do(es) your authoritative source(s) help you investigate your key questions/knowledge goals?
- What new knowledge are you gaining?
- What are you struggling with? Where are the gaps in your knowledge?
- Are there still things you're wondering about?
- How do your ideas relate to the real world and your everyday life?

ADD YOUR OWN QUESTIONS BELOW

- _____
- _____
- _____
- _____

Putting Assessment into Practice: During mini-conferences, the teacher is given the opportunity to get a sense of student's theories and ideas and the concepts they are digging into. Mini-conferences also give the teacher the chance to identify any misconceptions students' might be holding onto. The intent is not to use mini-conference time to "fix" these misconceptions, but to keep track and assess students' progress towards their stated goals: Is the research they are currently doing relevant and useful? Are they finding evidence to support their theories? Are the sources they are using reliable? Over time and repeated conferences the teacher can see if misconceptions are spreading, are not being addressed, or are blocking progress. If so, the teacher can design a mini-lesson, show a video, read a book, conduct a KB Circle, or co-design an activity focused on the tricky concept to help move the students forward. On the other hand, if students are progressing quickly, the teacher can help students dig deeper and make more connections between their goals, ideas, and findings. Mini-conferences also allow for differentiated instruction that can benefit ESL students as well as other students who are struggling because the teacher can provide them the opportunity to demonstrate their learning in an alternative way (not a pencil and paper task).

Tool: KB Teacher/Student Conference Assessment Report.

Created by: Jason Frenza, Junior/Intermediate teacher

Knowledge and Understanding of Knowledge Goals

- Student understands the main knowledge goals and big ideas
- Student understands how the knowledge goal connects to curriculum expectations

COMMENTS:

Application of the Knowledge Goal to Everyday Life

- Student makes connections between disciplinary concepts and their everyday life
- Student describes connections, similarities, and differences between knowledge goals

COMMENTS:

Communication of Knowledge Goal:

- Student uses key terms and vocabulary to express ideas
- Student organizes information clearly and coherently

COMMENTS:

Thinking and investigating:

- Student uses the KB process to gather relevant information
- Student uses critical and creative thinking skills to gather information
- Student investigates information from authoritative sources accurately

COMMENTS:



“I use anecdotal notes in combination with teacher conferences as a method of assessment — so I went back to the curriculum and Growing Success and explored how to track their learning. I created the Teacher/Student Conference Assessment Reports. Each element tackles one of the Achievement Chart categories. Then I look at the co-created knowledge goals the class and I created together at the onset of the unit, and I decide which single knowledge goal I’m going to look at in my mini-conference according to each achievement chart category, simply because I can’t cover everything. The teacher just takes notes here. It’s time consuming but it’s rich and meaningful assessment.”

— Jason Frenza



STUDENT-COMPOSED ASSESSMENTS

In Knowledge Building communities, students themselves are given the responsibility to reflect on their progress, their achievements, and their setbacks. They are encouraged to engage in both individual and group reflection, and to be involved in the process of evaluation and assessment as part of everyday work. On the following page are examples of tools to help students reflect upon important aspects of KB work, including their engagement and contribution habits, successes, and challenges related to idea development, collaboration skills, research strategies, and so on.

3. KB Circle Assessments/Rubrics

Description: The Knowledge Building Circle allows students to share their knowledge and build upon the knowledge of others in the classroom. KB Circle Rubrics are a cross-curricular assessment tool that can be customized for both teachers and students to use as a form of assessment. The rubric helps to put one of the 12 Principles of Knowledge Building, *Knowledge Building Discourse*, into practice, and can be used as an assessment for students' developing oral language and communication skills.

Putting Assessment into Practice: The use of KB Circle Rubrics supports differentiated instruction, as it allows students who sometimes struggle with the traditional pencil and paper tasks to communicate their ideas and develop confidence in sharing their knowledge with their peers and the teacher. Success Criteria for KB Circles (see below) can be co-created with students and/or given to students just prior to the very first KB Circle to help them monitor their own participation. After KB Circles, students can evaluate themselves on various communications skills such as: active listening, the communication of their ideas; connections and extensions of ideas to broader world or related problems; their expression and clarity of scientific concepts, etc. At the very end of the unit, students can also self-evaluate their metacognition skills. They identify their strengths and next steps as a contributor to a KB Circle. As a summative extension to this assessment tool, the teacher can complete a KB Circle Rubric for each student to evaluate his/her overall contribution level and development of communication and collaboration skills, as evident by his/her participation in KB Circles during the length of the KB study.

SUCCESS CRITERIA FOR KB CIRCLES

- I will explain my knowledge about key concepts I've been learning about using appropriate language and vocabulary
- I will contribute prior knowledge and ideas about the problems and questions being explored
- I will reflect and discuss new knowledge and learning I have acquired
- I will reflect and share questions, ideas, and information I'm still wondering about
- I will ask questions that will help me move forward and improve my ideas
- I will build on others' ideas and connect my learnings to the ideas and questions of the group

Tool: KB Circle Rubric, see pg. 141

Created by: Jason Frenza, Junior/Intermediate teacher

Tool: KB Circle Self-Evaluation, see pg. 139

Created by: Nizam Hussain, Intermediate teacher

Tool: Accountable Number Talks/KB Circle Rubric, Accountable Number Talks/KB Circle – Student Reflection Rubric, see pg. 141

Created by: Suzana Milinovich, Junior teacher

4. Inquiry Lab Books

Description: In Knowledge Building work, students are continually observing, questioning, visualizing, theorizing, reflecting, and self-assessing. In KB, these practices are not separate or isolated steps to be done one at a time, but are dynamic and interdependent processes. For instance, students need to be reflecting as they observe, visualizing or self-assessing as they

reflect, questioning and theorizing as they experiment, and so on. Inquiry Lab Books can provide space for students to record, organize, and reflect on all aspects of their KB work. Students record and describe their observations, ideas, questions, and reflections with the help of diagrams, jot notes, sketch notes, lists, reports, and so on. While Lab Books are commonly used in Science, they are also valuable in other subjects. For example, investigating primary source documents for History or Social Studies can inspire rich questions, and can set students on a meaningful course of action to help them develop their ideas. For Language Studies, students could keep an ongoing record of current events.

“Each entry in an Inquiry Lab Book is dated, which as a whole, creates a portfolio of a learner’s thinking and research processes over time. By reflecting on the qualitative nature of a learner’s entries, the teacher gains a picture of his or her developmental growth. Conversely, a test completed in isolation and under time restrictions, although a more straightforward process of quantitative data collection, represents only a fragmented picture – a mere slice of a learner’s knowledge, which may be distorted by the restraints and pressures of a test situation” (*Natural Curiosity*, 2011, pg. 24).

Inquiry Lab Books can provide a place for students to record and organize:

| |
|--|
| ● initial questions |
| ● theories/ideas |
| ● observational sketches of, and reflections on experiments |
| ● observations, reflections and notes on artifacts/primary sources |
| ● research from books, internet sources, and guest speakers |
| ● notes and/or drawings from field experiences |
| ● new questions and theories |

Adapted from *Natural Curiosity* (2011, pg. 24).

5. My Investigations and Record of Observation Logs:

Created by: Jason Frenza, Junior/Intermediate teacher

Description: These logs encourage students to record observations, insights, and ideas that arise during classroom experiments or during primary document investigation and analysis. They can be included as a component within an Inquiry Lab Book or folder to support students’ work. The Investigations and Record of Observation Logs can be used in any activity which requires careful observation, questioning and recording that can help guide future steps. The success criteria shown on the following page helps students to structure and reflect on their Investigation and Record of Observation Logs.

Putting Assessment into Practice: Students conduct an in-class experiment, or other investigative activity requiring close observation. During the process or directly afterwards, students create a Record of Observation Log in which they communicate their thinking and ideas by referring to direct observations that took place during the investigation. To help them demonstrate their thinking skills, students are provided opportunities to use diagrams to help them explain their

observations. A significant part of the Log is to record new learnings and new ideas that emerged from the investigation. Guided by the My Investigations and Record of Observations Success Criteria, students are encouraged to actively integrate any new information and ideas that they acquired within their pre-existing ideas or theories, and to connect how their new learnings and understandings relate to their main questions and to the learning/knowledge goals.

Tool: My Record of Observations Success Criteria

MY INVESTIGATIONS AND RECORD OF OBSERVATIONS SUCCESS CRITERIA

- I recorded my observations of the activity/experiment I/we completed
- I used appropriate terms, definitions and vocabulary to explain and describe my observations
- I described my observations clearly
- I used diagrams, sketch notes, or images to help me explain my observations when needed
- I explained the procedures, materials, and tools I/we used during the activity/experiment
- I recorded the findings and/or results of the activity/experiment and discussed their significance
- I completed my Record of Observations log.

MY OBSERVATION LOGS

- I discussed the procedures, materials, tools, and findings of the activity/experiment
- I discussed what I observed
- I used diagrams, sketch notes, or images to help explain my observations when needed
- I described my “New Learnings” (new information, questions, ideas that I gained as a result)
- I connected new ideas and learnings to my own and our community’s previous theories and ideas
- I described and made connections between science concepts and the real world.

Exemplar: For an example of student Record of Observation Log, see pg. 144

6. My Self-Assessment Logs

Created by: Jason Frenza, Junior/Intermediate teacher

Description: With My Self-Assessment Logs, students evaluate their own learning, ideas, and contributions to their KB community. These kind of logs can also be integrated within an Inquiry Lab Book or folder. Through the Self-Assessment Log, teachers gain an understanding of the following: how students articulate and understand the driving questions and learning/knowledge goals; how students are connecting authoritative sources to their theories and ideas; how they are making connections to real world issues; how they are reflecting upon their participation in KB Circles; and finally, how students perceive their strengths and next steps as a Knowledge Builder.

Putting Assessment into Practice: The My Self-Assessment Log supports meta-cognition practices in the classroom because it gives students the opportunity to actively reflect on their learning and helps them to chart the course of their own inquiry. The My Self-Assessment Log provides them the opportunity to self-reflect upon their strengths and next steps and where they need to continue to go with their knowledge goals.

Tool: Self-Assessment Log Success Criteria

SUCCESS CRITERIA FOR MY SELF-ASSESSMENT LOG

- I will use my knowledge from past learning experiences to help me complete my self-assessment log.
- I will evaluate my learning and participation in Knowledge Building Circle talks.
- I will include new learning and ideas that I've gained from Knowledge Building Circle talks and science inquiries.
- I will explain what I have learned by connecting [insert knowledge/learning goal here – e.g., *how forces act on and within structures* to my everyday life].
- I will discuss my strengths when it comes to participating in class.
- I will evaluate my goals and think about next steps regarding how I can improve my recording of [insert activities here – e.g., my Observations, my Picture Learning Logs, my contributions to Knowledge Talk Reflections, etc.).

Exemplar: For an example of a Student Self-Assessment Log, see pg. 145

7. Knowledge Talk Reflections

Created by: Jason Frenza, Junior/Intermediate teacher

Description: A Knowledge Talk Reflection is a written reflection (approximately 1 page) that allows students to describe the learning that has taken place during the inquiry process. These are typically completed after a Knowledge Building Circle and provide students with an opportunity to reflect upon the circle discussion. In a Knowledge Talk Reflection, students explain the key concepts that they're engaging in, describe any new ideas or information that they have brought to that Knowledge Building Circle, comment on how their prior knowledge helped them to understand and make connections during the discussion, and reflect upon information and ideas that they are still wondering about or that puzzles them. The prompt for further questioning and wonderings can help students to develop higher-level questioning skills because they challenge students to keep probing and digging deeper.

Putting Assessment into Practice: Knowledge Talk Reflections give the teacher a sense of how a student is contributing to the KB community — how his/her discourse is developing over time, how his/her contributions help to advance shared knowledge, and how his/her communication and interpersonal skills are growing. Students are encouraged to use the KB Circle scaffolds ("My Theory," "I Still Need to Understand," "Another Perspective Is," etc.) in their reflection writing to help explain their thinking. The teacher can see how students are sharing what they have learned and how they are building on not only their own ideas but the theories that their classmates are sharing during the KB Circles.

Exemplar: See sample Knowledge Talk Reflections, see pg. 142-143

DRAWINGS AND VISUAL MODES OF COMMUNICATION

To honour different learning styles and expressive modes, teachers can encourage students to communicate their ideas and understandings in visual forms. This allows students who have more difficulty expressing their thoughts in written form to showcase their ideas. It also allows the teacher a different access point to students' ideas.

1. Picture Learning Logs

Created by: Jason Frenza, Junior/Intermediate teacher

Description: The Picture Learning Log included in this resource is one example of embedding visual forms of communication for the purposes of assessment into the Knowledge Building process. The Picture Learning Logs both allow the teacher to see and assess students' thinking, and to also help students advance their own ideas and Knowledge Building work.

Putting Assessment into Practice: The Picture Learning Log directly connects to inquiry questions/problems and knowledge goals. The students select a part of the problem or goal that is meaningful to them and are then asked to create a visual representation of their learning that illustrates key disciplinary concepts and theories in the form of a picture, diagram, timeline, graph, etc. Through this visual they need to be communicating the knowledge they have gained through the inquiry process so far. This learning activity allows students to illustrate rich connections between disciplinary theories and concepts and their everyday lives. Students complete a Picture Learning Log once they are about a quarter way through the KB process (e.g., once they have done a fair amount of initial research, had a mini-conference, participated in KB Circles, have demonstrated an understanding of the knowledge goal/key concept, etc). The Picture Learning Log helps students to consolidate their understandings repeatedly through the KB process.

Tool: Success Criteria for Picture Learning Logs.

SUCCESS CRITERIA FOR PICTURE LEARNING LOGS

- I will show my learning and illustrate my ideas through clear diagrams, sketch notes, or images that relate to important (*historical, scientific, social studies, etc.*) concepts and questions
- I will label my diagrams with appropriate terms and definitions
- I will explain how my diagram, sketch note or image relates to my/our theories and ideas, and how it represents any new learning.

Exemplar: For samples of student Picture Learning Logs, see pg. 146-147

KNOWLEDGE FORUM

We spent time discussing the Assessment Tools available on Knowledge Forum throughout pages 90 and 91 of this resource and so do not cover those here. However, we include teacher-invented assessment tools that can help both teachers and students engage in meaningful assessment of students' participation and contributions on Knowledge Forum.

1. Scaffold Use

Created by: Glenn Wagner, Senior teacher

Description: This assessment tool can be used in tandem with the automated assessment features on Knowledge Forum (e.g., the Scaffold Tracker Tool, the Contribution Tool). It is designed for student use and helps them keep track of all the different types of contributions that they are making to the online discussion. This helps increase students' awareness not only about their own ways of contributing but about how they are helping to advance community knowledge, and how they might be able to expand their contribution repertoires in meaningful ways.

Putting Assessment into Practice: Students are given weekly tracking sheets and keep their contribution tally for their own records. They can hand these in periodically over the course of KB work, they can hand them in as part of a Self-Selected Student Portfolio (see pg. 125) at the end of a unit, or they can simply be called upon at any point in the course of the study to show their contribution sheets.

Knowledge Building Contribution Tracking Sheet WEEK 1

| Sample Scaffolds | Tally | Weighting | Total Score |
|--------------------------------|-------|-----------|-------------|
| A definition | | x 1 | |
| An example | | x 1 | |
| New information | | x 1 | |
| Video with explanation | | x 2 | |
| Picture with explanation | | x 2 | |
| I need to understand | | x 2 | |
| This idea cannot explain | | x 2 | |
| Building on your idea | | x 3 | |
| An analogy | | x 3 | |
| Aha! moment | | x 3 | |
| Experimental evidence | | x 4 | |
| My theory | | x 4 | |
| A theory I found | | x 4 | |
| An alternate theory | | x 4 | |
| Putting our knowledge together | | x 5 | |
| Decision | | x 5 | |

SUMMATIVE ASSESSMENT TOOLS

Many educators and students say that it can be difficult to put an “ending point” to a KB inquiry, as there are always more questions to pursue and new avenues to follow that go deeper into a knowledge problem. However, practical constraints and assessment requirements often demand summative assessments of KB work. Also, having a project towards which students can apply and channel the knowledge they gain during the KB process can be a fun and motivating way to consolidate students’ understandings and close off the often challenging yet exciting process of improving ideas! Below are some examples of creative and effective summative assessments that are designed to help students articulate their own deepest understandings and showcase how their ideas have advanced.

1. Summative Knowledge Building (KB) Circles

Created by: Glenn Wagner, Senior teacher

Description: Students engage in a great amount of discourse and group discussion throughout the process of KB work. Summative KB Circles allow students to be evaluated in a similar mode, through verbal conversations with peers and with the teacher. Unlike a regular KB Circle, which is highly exploratory and not typically subject to evaluation, each student is asked to come to the table ready to be able to speak to the problem and/or question they have been working on in a deep, fluent, and knowledgeable way.

Putting Assessment into Practice: At the end of a KB study, small groups of students (3-4) who have been working on similar problems or questions meet together with the teacher in a KB Circle. The students are all asked to describe to the group the story of their greatest knowledge advance — “What questions and theories did they start out with?” “How did they grow their ideas?” “What authoritative sources did they turn to?” “Which of their peers’ ideas helped them move their thinking forward?” “How did they contribute to others’ ideas?” “How did they deal with contradictory information?” “Did they do any experiments to test theories?” They are also encouraged to identify challenges and existing gaps in knowledge, as well as directions that they could pursue and steps they could take in order to develop their ideas and extend their knowledge further in the future. Students are expected to be able to be responsive to any questions or comments that their peers or the teacher pose for them throughout this discussion. (Suggestion: Put this into a “fishbowl” for the rest of the class to observe.)

2. E-Portfolios

Created by: Glenn Wagner, Senior teacher

Description: E-Portfolios allow students to demonstrate their greatest knowledge advances and deepest understandings in writing. Students use the knowledge they and their community generated on Knowledge Forum as the main reference source for their E-Portfolio. Rather than take an essay style format, an E-Portfolio asks students to synthesize the process they went through developing their ideas and to communicate the best explanation possible to their main problem

of understanding. Students are asked to describe and show the evolution of their ideas from their initial questions on to their final explanation. Students are expected to incorporate and elaborate on their own KF notes, include evidence from authoritative sources, and add contributions from the classroom community that helped them advance their ideas.

Putting Assessment into Practice: Students are given resources to help guide the development of their E-Portfolio, the “Steps to Creating an E-Portfolio” guide, and the E-Portfolio Rubric (see Tool: E-Portfolio Rubric directly below).

Tool: Steps to Creating an E-Portfolio, see pg. 148

Tool: E-Portfolio Rubric

E-PORTFOLIO RUBRIC

Name: _____

The criteria for selecting ‘best’ notes are as follows. Did the notes you select represent:
(1 = not representative, 4 = very representative)

1. Working at the cutting edge

1 2 3 4

2. Progressive problem solving

1 2 3 4

3. Collaborative effort:

1 2 3 4

4. Identifying high points:

1 2 3 4

Score ____/16

Exemplar: For an example of a student E-Portfolio, see pg. 148-150

3. Knowledge Building Project Contribution Rubric

Created by: Glenn Wagner, Senior teacher

Description: The Knowledge Building Project Contribution Rubric allows students to self-assess their engagement and participation in all aspects of KB work (including KF, KB Circles, general discussion and group work, etc.)

Knowledge Building Project: Contribution Rubric

Name: _____

(1 = never, 4 = always)

1. Consistently met target contribution score within Knowledge Forum:

1 2 3 4

2. Contributions were in-depth, and attempted to bring together other people's work to synthesize with your own.

1 2 3 4

3. Continually improved ideas and theories of your own and others in your area of expertise by building upon others' theories and ideas.

1 2 3 4

4. Provided evidence of understanding through examination of primary sources of information

1 2 3 4

Score ____/16

4. Showing a Learning Journey on a Road Map

Created by: Elaine Heaver, Junior teacher

Description: While pursuing explanations to their KB questions, students show their learning journeys on individual Road Maps.

Putting Assessment into Practice: On a large piece of blank ledger paper, students start by illustrating themselves in the top left corner with a thought bubble showing the question they were wondering about. From there, they draw a road/path/footsteps (or whatever mode of transportation they want) to their first stop (e.g., their desk to plan an experiment, a classroom iPad to find some information). The "road" would continue to show each step they took along the way. The key is to show that their journeys are not a straight road, but a winding path with a variety of obstacles and twists and turns. Students include such things as:

- **speed bumps** (things that slow them down, such as trouble finding needed materials),
- **detours** (when they have to take a different approach to get themselves back on track)
- **forks in the road** (when they have choices to make that affect their progress)
- **road blocks** (an unforeseen difficulty that may stop their progress)

The most rewarding part of the journey is seeing the steps students took to overcome each obstacle. As students see classmates struggle and overcome challenges, it encourages them to persevere and look for creative solutions. As one student commented, "If your road to success is pretty straight, you didn't challenge yourself!"

5. Knowledge Building Student Self-Selected Portfolios (+ Accompanying Evaluation)

Description: As a culminating product, students are asked to collect and submit the work that they have done over the course of the Knowledge Building study that they feel represents their deepest understandings and greatest knowledge advances. These pieces can also be directly related to communal knowledge goals. These portfolios allow the teacher to assess and evaluate students' thinking and their ability to gather relevant information and work through the KB process.

The Self-Selected Portfolio itself includes various assignments and pieces of work that students have completed throughout the KB process. Each of the pieces included in the Portfolio applies directly to one out of the four achievement chart categories represented in the evaluation. For example, in Jason Frenza's science class, the Portfolios include: i) a student's Knowledge Talk Reflection (Knowledge and Communication); ii) a Picture Learning Log (Thinking and Application); iii) Record of Observations (Thinking and Application); iv) My Observation Journals (Thinking); v) a My Self-Assessment Log (Application); vi) a KB Circle Student Self-Assessment Rubric (Knowledge and Communication).

Putting Assessment into Practice: Knowledge Building Student Self-Selected Portfolios allow students to collect and research information directly related to their main questions and learning/knowledge goals. The teacher is able to assess and evaluate students' critical thinking skills, their knowledge and understanding of disciplinary concepts, their communication skills, their ability to express and organize ideas and information, their ability to make connections between key concepts and the real world, and their ability to gather relevant information and work through the KB process.

6. Knowledge Surveys

Created by: Glenn Wagner, Senior teacher

Description: Knowledge Surveys are a great way for students to self-assess their own growth in knowledge advancement and understanding. It is also a wonderful way for a teacher to see how students have developed conceptual understanding and content knowledge.

Putting Assessment into Practice: Knowledge Surveys are administered at the very beginning and end of a KB study.

Exemplar: See a pre/post Knowledge Survey, see pg. 151-153

EVALUATION AND REPORTING

The sheer amount of documentation and artifacts you may accumulate from students at the end of a KB study can make evaluation and reporting a daunting task. On the other hand, you will likely not be short of material to turn to when report card time arrives. **KB teachers often find that the Learning Skills and Work Habits section is a great place to document important observations and evaluations about students** that have been amassed throughout the process of a Knowledge Building Inquiry. As outlined in *Growing Success* (2009, pg. 11), the Learning Skills and Work Habits chart (see below) pinpoints desired behaviours and traits associated with each category. Many of the behavioural Look-Fors listed in the chart below are highly relevant to Knowledge Building and encompass competencies and skills needed for creative work with ideas.

| Learning Skills and Work Habits | Sample Behaviours The student: |
|---------------------------------|--|
| Responsibility | <ul style="list-style-type: none"> fulfills responsibilities and commitments within the learning environment completes and submits class work, homework, and assignments according to agreed-upon timelines takes responsibility for and manages own behaviour |
| Organization | <ul style="list-style-type: none"> devises and follows a plan and process for completing work and tasks establishes priorities and manages time to complete tasks and achieve goals identifies, gathers, evaluates, and uses information, technology, and resources to complete tasks |
| Independent Work | <ul style="list-style-type: none"> independently monitors, assesses, and revises plans to complete tasks and meet goals uses class time appropriately to complete tasks follows instructions with minimal supervision |
| Collaboration | <ul style="list-style-type: none"> accepts various roles and an equitable share of work in a group responds positively to the ideas, opinions, values, and traditions of others builds healthy peer-to-peer relationships through personal and media-assisted interactions works with others to resolve conflicts and build consensus to achieve group goals shares information, resources, and expertise and promotes critical thinking to solve problems and make decisions |
| Initiative | <ul style="list-style-type: none"> looks for and acts on new ideas and opportunities for learning demonstrates the capacity for innovation and a willingness to take risks demonstrates curiosity and interest in learning approaches new tasks with a positive attitude recognizes and advocates appropriately for the rights of self and others |
| Self-Regulation | <ul style="list-style-type: none"> sets own individual goals and monitors progress towards achieving them seeks clarification or assistance when needed assesses and reflects critically on own strengths, needs, and interests identifies learning opportunities, choices, and strategies to meet personal needs and achieve goals perseveres and makes an effort when responding to challenges |

Below, KB primary teachers Angela Hoffman and Mubina Panju provide an example of evaluative comments that incorporate and reflect a student’s growth in Knowledge Building capacities and skills in the Learning Skills and Work Habits section of the provincial report card (see the case study Knowledge Building in Primary: What Makes a Community? in the KB Case Studies package available via [The Learning Exchange](http://thelearningexchange.ca/wp-content/uploads/2017/04/1_2-KB-in-Primary_What-Makes-a-Community_AODA.pdf) at http://thelearningexchange.ca/wp-content/uploads/2017/04/1_2-KB-in-Primary_What-Makes-a-Community_AODA.pdf).

Kindergarten: (Science and Technology). _____ is encouraged to communicate her ideas clearly so that others can understand her thought processes and build/respond to her ideas. This helps to solidify understanding of concepts and will help _____ think of new ideas for further inquiry. _____ investigates and uses the computer and iPad with assistance, and is working to build independence when using these tools for Knowledge Building.

Grade One: (Learning Skills). _____ is able to use his own ideas and experiences to support his learning. _____ demonstrates curiosity and an interest in learning about the world around him. He is also open to new ideas and takes appropriate risks. During our Knowledge Building Inquiry Unit about the community, _____ readily participates and provides interesting and insightful comments and questions. _____ will be encouraged to think of new ideas to further inquiry.

LINKING THE LEARNING SKILLS TO THE KB PROGRESSIONS

The **KB Progression Charts** (see pgs. 65-69) incorporate many of the elements described in the Learning Skills and Work Habits framework. The KB Progressions trace key qualities and Look-Fors across four main dimensions critical to successful Knowledge Building environments: *Fostering Collective Discourse; Community Norms; Developing Ideas; and Meta-Cognition/Meta-Talk*. Take, for example, these sample points found in the Community Norms KB Progression:

- Students are able to demonstrate collaboration and how they help build a sense of community.
- Students are using appropriate language and behaviours (e.g., turn-taking) to respectfully challenge or add on to each other’s thinking.
- Students are showing evidence of helping to establish a culture of trust, acceptance, and safety.
- Students are open to diverse ideas and individual differences between one’s own ideas and the ideas of others.

These behaviours are directly relevant to the descriptions of both Collaboration and Initiative, as outlined in the Learning Skills and Work Habits framework. The table below draws connections between the four KB Progressions and the Learning Skills and Work Habits categories.

| KB Progression | Learning Skills and Work Habits |
|--------------------------------|--|
| Fostering Collective Discourse | Collaboration, Initiative |
| Community Norms | Responsibility, Collaboration, Self-Regulation, Independent Work |
| Developing Ideas | Organization, Initiative, Collaboration |
| Meta-Cognition/Meta-Talk | Self-Regulation, Initiative |

KB Principles and practices align effectively with not only the Learning Skills and Work Habits, but also with 21st century skills and competencies. The chart below shows connections between the Learning Skills, 21st century competencies, and the 12 KB principles, in a coherent framework. Assessments that target particular behaviours relevant to each category are also considered.

| Learning Skills & Work Habits | Ontario's Draft 21st Century/Global Competencies | KB Principles | Assessments targeted to: |
|-------------------------------|---|--|--|
| Responsibility | Global Citizenship | <ul style="list-style-type: none"> Community Knowledge, Collective Responsibility Democratizing Knowledge | <ul style="list-style-type: none"> Individual contributions to both personal and collective goals (e.g. KB Circle Reflections, Self-Assessment Logs, etc) |
| Organization | Learning to Learn/ Self-Aware & Self-Directed Learning | <ul style="list-style-type: none"> Epistemic Agency Knowledge Building Discourse Constructive Use of Authoritative Sources | <ul style="list-style-type: none"> Taking on high-level responsibilities like planning next steps, organizing or creating KF views, proposing experiments, surveys or designs to test ideas and gather data, setting top-level goals Self and group reflection Engaging with authoritative sources Independent |
| Independent Work | Learning to Learn/ Self-Aware & Self-Directed Learning | <ul style="list-style-type: none"> Epistemic Agency | <ul style="list-style-type: none"> Individual contributions to both personal and collective goals (e.g. Self-Assessment Log, Learning Journey Road Maps, etc) Summative assessments (Summative KB Circles, E-portfolios, Self-Selected Portfolio) |
| Collaboration | Collaboration, Communication | <ul style="list-style-type: none"> Community Knowledge, Collective Responsibility Democratizing Knowledge Knowledge Building Discourse | <ul style="list-style-type: none"> Community dynamics, student attitudes and collective culture (e.g. KB Circle and other Student Anecdotes) KF activity, such as degree students are reading and responding to each other Using appropriate scaffolds in discourse to foster a critical and kind collective culture |
| Initiative | Innovation, Creativity & Entrepreneurship Critical Thinking & Problem Solving | <ul style="list-style-type: none"> Epistemic Agency Improvable Ideas Idea Diversity Rise Above Pervasive Knowledge Real Ideas, Authentic Problems Embedded, Concurrent, & Transformative Assessment | <ul style="list-style-type: none"> Demonstrate a "KB" stance (e.g. willingness to contribute ideas, take risks, consider multiple perspectives and ideas, encourage and ensure equitable participation, draw real-world connections, give and respond to critical feedback, developing rich questions Engage in high-level knowledge work such as being reflective, designing next steps for work, setting top-level goals |
| Self-Regulation | Learning to Learn/ Self-Aware & Self-Directed Learning | <ul style="list-style-type: none"> Epistemic Agency Pervasive Knowledge Embedded, Concurrent & Transformative Assessment | <ul style="list-style-type: none"> Taking on high-level responsibilities for individual and group Engaging in self and group reflection and assessment |

TOOLS FOR EVALUATION

The Ontario Provincial Curriculum includes an **achievement chart** that provides a common framework for assessing performance standards for each Grade across each discipline. As described in *Growing Success*, the achievement chart “enables teachers to make consistent judgments about the quality of student learning based on clear performance standards and on a body of evidence collected over time. It also provides teachers with a foundation for developing clear and specific feedback for students and parents (2009, pg. 16). The achievement chart is comprised of the following categories:

- **Knowledge and Understanding:** Subject-specific content acquired in each Grade/course (knowledge), and the comprehension of its meaning and significance (understanding).
- **Thinking:** The use of critical and creative thinking skills and/or processes.
- **Communication:** The conveying of meaning through various forms.
- **Application:** The use of knowledge and skills to make connections within and between various contexts (2009, pg.18).

Using the achievement chart categories as a framework, we introduce two KB evaluation tools that can be used to inform final reporting (the Ideas, Connections, Extensions (ICE) Rubric and the Knowledge Building Student Self-Selected Portfolio Rubric). We also list the relevant assessment tools, described in the Innovation Gallery, that can be used to inform reporting for each of the achievement chart categories. Note that many of the assessment tools are applicable to more than one of the achievement chart categories depending on how they are used in the classroom.

KNOWLEDGE AND UNDERSTANDING

Knowledge of content entails use of facts, terminology, definitions, safe use of tools, equipment, and materials. Understanding of content entails use of concepts, ideas, theories, principles, procedures, and processes.

1.The ICE Rubric to Assess Idea Development

Description: The ICE Rubric developed by Fostaty-Young and Wilson (2004) is featured in *Natural Curiosity* (2011) and provides a useful tool applicable across Grades and subject matter for assessing growth in student understanding and idea development. The ICE rubric can be applied to students’ written, verbal or online discourse. The ICE Rubric can be used to explore the depth of student theories and ideas, the extent to which they elaborate their ideas in their contributions, as well as the clarity with which they communicate those ideas to the community. Similarly, jotting down whether students are expressing Ideas, making connections, or demonstrating extensions of ideas during KB Circles can provide rich data on the extent and depth of student understanding.

Two examples of ICE Rubrics are given below. The first depicts guiding principles for each category, and the second is adapted for junior Grades. The guiding principles can be used to help inform the design of customized ICE Rubrics.

Tool: Found in Natural Curiosity (2011), pg. 33

| IDEAS | CONNECTIONS | EXTENSIONS |
|--|--|---|
| <ul style="list-style-type: none"> the fundamentals basic facts vocabulary/definitions details elemental concepts | <ul style="list-style-type: none"> explain the relationship or connection among the basic concepts explain a relationship or connection between new learning and what they already know use phrases such as, "Oh, that reminds me of..." or "That's just like..." | <ul style="list-style-type: none"> apply their new learning in novel ways, apart from the initial learning situation answer conjectural questions such as: "So, what does this mean?" "How does this shape my view of the world?" |

Tool: Found in Natural Curiosity (2011), pg. 34 ("Where do energy sources come from?")

| ELEMENTS/ CATEGORIES | IDEAS | CONNECTIONS | EXTENSIONS | |
|--|--|---|---|---|
| | Level 1 | Level 2 | Level 3 | Level 4 |
| Knowledge and Understanding (<i>facts, terminology, definitions, concepts</i>) | <ul style="list-style-type: none"> I can give a basic definition for the meaning of renewable and non-renewable resources | <ul style="list-style-type: none"> I can use examples to support definitions I can connect everyday activities to renewable or non-renewable energy sources I can explain the pros and cons of each source of energy | <ul style="list-style-type: none"> I can propose suggestions for conserving energy | <ul style="list-style-type: none"> I can explain what I might do differently I can explain what others can do |
| Communication (<i>expression and organization of ideas and information</i>) | <ul style="list-style-type: none"> I can communicate clearly and get my point across so that others understand what I am trying to say I can express my ideas in an organized and logical manner | <ul style="list-style-type: none"> I can expand my thinking by connecting ideas to information from my own experiences and other sources | <ul style="list-style-type: none"> I can explain how and why my thinking has changed | <ul style="list-style-type: none"> I can ask new questions I can invite my classmates to participate |

2. Knowledge Building Student Self-Selected Portfolio Evaluation

Description: Grading of Student Self-Selected Portfolios is guided by the accompanying Student Self-Selected Portfolio Evaluation framework adapted from the Achievement Chart outlined in the curriculum document (Ontario Elementary Science Curriculum, 2007, p. 26-27). The Self-Selected Portfolio itself includes various assignments and pieces of work that students have completed throughout the KB process, each of which applies directly to one out of the four achievement chart categories represented in the Evaluation (as described on pg. 125).

Putting Assessment into Practice: This evaluation is an example of the kinds of assessment and evaluation innovations that teachers create to bring together formal evaluations with important KB competencies. The evaluation is completed at the conclusion of a KB inquiry.

Tool: Knowledge Building Student Self-Selected Portfolio Evaluation. The evaluation on the following page is focused on science, but can be easily adapted for other subjects.

Created by: Jason Frenza, Junior/Intermediate teacher

KNOWLEDGE BUILDING STUDENT SELF-SELECTED PORTFOLIO EVALUATION

| Achievement Chart Category | Level 1 | Level 2 | Level 3 | Level 4 |
|--|---|--|--|---|
| <p>Knowledge and Understanding</p> <p>Student demonstrates knowledge of science content during Knowledge Building talks</p> <p>Student understands new science concepts learned</p> | <p>Student demonstrates little understanding of science content when sharing information during Knowledge Building talks</p> <p>Student understands very little new information learned in class when sharing knowledge during Knowledge Building talks</p> | <p>Student demonstrates some understanding of science content when sharing information during Knowledge Building talks</p> <p>Student understands some new information learned in class when sharing knowledge during Knowledge Building talks</p> | <p>Student demonstrates an understanding of science content when sharing information during Knowledge Building talks</p> <p>Student understands new information learned in class when sharing knowledge during Knowledge Building talks</p> | <p>Student confidently demonstrates an understanding of science content when sharing information during Knowledge Building talks</p> <p>Student precisely understands new information learned in class when sharing knowledge during Knowledge Building talks</p> |
| <p>Thinking</p> <p>Develops ideas through science inquiry process</p> <p>Picture Learning Logs demonstrate critical thinking skills by analyzing, interpreting and drawing conclusions</p> <p>Record of Observations demonstrates use of processing skills and strategies</p> | <p>Student develops very few ideas through the inquiry process</p> <p>Picture Learning Logs demonstrate very few critical thinking skills of analyzing, interpreting and drawing conclusions</p> <p>Student records observations using very few critical and creative ideas</p> | <p>Student develops some ideas through the inquiry process</p> <p>Picture Learning Logs demonstrate some use of critical thinking skills by analyzing, interpreting and drawing conclusions</p> <p>Student records observations using some critical and creative ideas</p> | <p>Student develops many new ideas through the inquiry process</p> <p>Picture Learning Logs demonstrate many critical thinking skills by analyzing, interpreting and drawing conclusions</p> <p>Student records observations using critical and creative ideas</p> | <p>Student develops excellent ideas through the inquiry process</p> <p>Picture Learning Logs demonstrate excellent critical thinking skills by analyzing, interpreting and drawing precise conclusions</p> <p>Student records observations using many critical and creative ideas</p> |
| <p>Communication</p> <p>Expression and organization of ideas and information</p> <p>Use of conventions, vocabulary, and terminology</p> | <p>Student expresses and organizes ideas and information unclearly</p> <p>Student uses very few science conventions and terminology</p> | <p>Student sometimes expresses and organizes ideas and information clearly</p> <p>Student sometimes uses science conventions and terminology</p> | <p>Student sometimes expresses and organizes ideas and information clearly</p> <p>Student sometimes uses science conventions and terminology</p> | <p>Student precisely expresses and organizes ideas and information clearly</p> <p>Student uses excellent science conventions and terminology</p> |
| <p>Application</p> <p>Transfer of knowledge and skills</p> <p>Makes connections between science concepts and the real world</p> | <p>Student transfers very little knowledge and information to new concepts</p> <p>Student makes very few connections to the real world</p> | <p>Student transfers some knowledge and information to new concepts</p> <p>Student makes some connections to the real world</p> | <p>Student transfers knowledge and information to new concepts</p> <p>Student makes connections to the real world</p> | <p>Student confidently transfers knowledge and information to new concepts</p> <p>Student makes excellent connections to the real world</p> |

ASSESSMENT TOOLS TO INFORM EVALUATION OF STUDENT ACHIEVEMENT

KNOWLEDGE AND UNDERSTANDING

- Acquisition of subject-specific content in each grade (e.g., facts, genres, terms, definitions, techniques, elements, principles, forms, structures, conventions).
- Comprehension of the meaning and significance of content (e.g., concepts, ideas, procedures, processes, themes, relationships among elements, informed opinions).

Assessment Tools to Inform Evaluation and Reporting for “Knowledge and Understanding”

The following assessment tools, as described in the Innovation Gallery, can be used to help evaluation and reporting for this achievement category.

Formative Tools

- Anecdotal Organizers; Mini-Conference notes
- Student-Composed Assessments: Inquiry Lab Books; Knowledge Talk Reflections

Summative Tools

- Learning Journey Road Map; Summative KB Circles; E-Portfolios

Knowledge Forum Tools (see pgs. 106-108 for an overview of Knowledge Forum assessment tools)

- Vocabulary Tool; Qualitative contribution assessment

THINKING

- Use of initiating and planning skills and strategies (e.g., formulating questions, identifying the problem, developing hypothesis, scheduling, selecting strategies and resources, developing plans).
- Use of processing skills and strategies (e.g., performing and recording, gathering evidence and data, observing, manipulating materials and using equipment safely, solving equations, proving).
- Use of critical/creative thinking processes, skills, and strategies (e.g., analyzing, interpreting, problem solving, evaluating, forming and justifying conclusions based on evidence).

Assessment Tools to Inform Evaluation and Reporting for “Thinking”

The following assessment tools, as described in the Innovation Gallery, can be used to help evaluation and reporting for this achievement category.

Formative Tools

- Anecdotal Organizers; Mini-conference notes

- Student-Composed Assessments: Inquiry Lab Books; My Investigations and Record of Observations Journal
- Visual Modes: Picture Learning Logs

Summative Tools

- Learning Journey Road Map; Summative KB Circles; E-Portfolios

Knowledge Forum (see pgs. 106-108 for an overview of Knowledge Forum assessment tools)

- Scaffold Tracker Tool; Use of advanced features such as Rise Above, Promising Ideas Tool, or creating/re-organizing KF views

COMMUNICATION

- Expression and organization of ideas and information (e.g., clear expression, logical organization) in oral, visual, and/or written forms (e.g., diagrams, models).
- Communication for different audiences (e.g., peers, adults) and purposes (e.g., to inform, to persuade) in oral, visual, and/or written forms.
- Use of conventions, vocabulary, terminology of the discipline in oral, visual, and/or written forms (e.g., symbols, formulae, scientific notation, S.I. units).

Assessment Tools to Inform Evaluation and Reporting “Communication”

The following assessment tools, as described in the Innovation Gallery, can be used to help evaluation and reporting for this achievement category.

Formative Tools

- Student-Composed Assessments: KB Circle Rubrics, Knowledge Talk Reflections, Inquiry Lab Books, My Self-Assessment Rubric
- Visual Modes: Picture Learning Logs

Summative Tools

- Learning Journey Road Map; Summative KB Circles; E-Portfolios

Knowledge Forum (see pgs. 106-108 for an overview of Knowledge Forum assessment tools)

- Contribution profiles (# of contributions written, read, # of build-on notes, # of reference notes); Qualitative contribution assessment; Use of diagrams and images in contributions; Vocabulary Tool; Scaffold Tracker Tool

APPLICATION

- Application of knowledge and skills (e.g., concepts and processes, use of equipment and technology, investigation skills) in familiar contexts.
- Transfer of knowledge and skills (e.g., concepts and processes, use of equipment and technology, investigation skills) in unfamiliar contexts.
- Making connections between science, technology, society, and the environment (e.g., assessing the impact of science and technology on people, other living things, and the environment).

- Proposing courses of practical action to deal with problems relating to science, technology, society, and the environment.

Assessment Tools to Inform Evaluation and Reporting for “Application”

The following assessment tools, as described in the Innovation Gallery, can be used to help evaluation and reporting for this achievement category.

Formative Tools

- Anecdotal: Assessing Students’ Activities and Progress Chart; Mini-Conference notes
- Student-Composed Assessments: Inquiry Lab Books, My Self-Assessment Logs
- Visual Modes: Picture Learning Logs

Summative Tools

- Summative KB Circles; E-Portfolios

Knowledge Forum (see pgs. 106-108 for an overview of Knowledge Forum assessment tools)

- Making connections across multiple views; Qualitative assessment of student contributions

ASSESSMENT EXEMPLARS: TEACHER TOOLS AND STUDENT WORK

ASSESSMENT EXEMPLARS: TEACHER TOOLS AND STUDENT WORK

| | |
|--|-----|
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Understanding Structures And Mechanism

Our Goals

- To build different structures.
- How are structures and mechanisms made?
- What is a force? ✓
- What might the different types of forces be that act on structures? ✓
- To learn about how structures and forces interact with different structures.
- We want to build a structure to see if force can knock it down (how they effect or change the structure).
- To create forces and apply them ✓
- Find out the different natural phenomenon's in our world and how they impact our world.
- To find out which forces help structures and don't. ✓

Knowledge Building Circle Rubric

Knowledge Building Circles Rubric

Name: _____

Date: _____

Knowledge Building Learning Goal: _____

I am demonstrating Active Listening Skills

- I ask questions to deepen my understanding of the topic Level 1 Level 2 Level 3 Level 4
- I communicate ideas clearly making connections to the ideas of others Level 1 Level 2 Level 3 Level 4
- I summarize my research clearly using specific examples from my inquiry Level 1 Level 2 Level 3 Level 4

Demonstrating Understanding

- I explain my research related to my learning goal using important ideas Level 1 Level 2 Level 3 Level 4

Extending Understanding

- I extend my understanding of the learning goal using my prior knowledge Level 1 Level 2 Level 3 Level 4
- I extend my understanding of the learning goal to the real world Level 1 Level 2 Level 3 Level 4

Clarity and Coherence

- I communicate my ideas clearly so my peers understand my ideas Level 1 Level 2 Level 3 Level 4
- I present my ideas using vocabulary related to my learning goals. Level 1 Level 2 Level 3 Level 4

My strengths...

My Next Steps...

Knowledge Building Circle Self-Evaluation

Adapted from: IQ: A Practical Guide to Inquiry-Based Learning (Watt & Coyle, 2014, pg. 146.)

Knowledge Building Circle Self-Evaluation

Name: _____

Date: _____

Topic: _____

o How did you contribute to today's discussion? Add a comment beneath the choices you checked off.

- I asked a question that related to a preceding idea

- I made a comment that showed interest in what someone else said

- I made a connection between two ideas

- I used body language to support other speakers

- I built onto someone else's thoughts

- I disagreed in a respectful way

Accountable Number Talk/Knowledge Building Circle Rubric

| Criteria | Level 1 | Level 2 | Level 3 | Level 4 |
|--|---|---|---|---|
| Student demonstrates knowledge of math content during Number Talks | Student demonstrates little understanding of number concepts when sharing information during Number Talks | Student demonstrates some understanding of number concepts when sharing information during Number Talks | Student demonstrates an understanding of number concepts when sharing information during Number Talks | Student confidently demonstrates an understanding of number concepts when sharing information during Number Talks |
| Student expresses mathematical thinking with clarity and logical organization when communicating in number talks | Student expresses thinking with clarity and organization with limited effectiveness | Student expresses thinking with clarity and organization with some effectiveness | Student expresses thinking with clarity and organization with considerable effectiveness | Student expresses thinking with clarity and organization with a high degree of effectiveness |
| Student communicates orally to justify a mathematical solution, or express a mathematical argument, using mathematical vocabulary | Student communicates using mathematical vocabulary with limited effectiveness | Student communicates using mathematical vocabulary with some effectiveness | Student communicates using mathematical vocabulary with considerable effectiveness | Student communicates using mathematical vocabulary with a high degree of effectiveness |

Accountable Number Talk/Knowledge Building Circle Student Reflections Rubric

| Criteria | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|--|--|--|
| Accountable Number Talk/ Knowledge Building Circle Student Reflections Rubric | Student expresses thinking with clarity and organization with limited effectiveness | Student expresses thinking with clarity and organization with some effectiveness | Student expresses thinking with clarity and organization with considerable effectiveness | Student expresses thinking with clarity and organization with a high degree of effectiveness |
| Student expresses thinking with clarity and organization with a high degree of effectiveness | Student communicates using mathematical vocabulary with limited effectiveness | Student communicates using mathematical vocabulary with some effectiveness | Student communicates using mathematical vocabulary with considerable effectiveness | Student communicates using mathematical vocabulary with a high degree of effectiveness |



Knowledge Talk Reflection

Mon Nov 7 - 14

In this knowledge talk the focus was changing states of matter. We learned the name of the phase changes and how the change happens; like how a liquid can go to a solid if it is cold enough. A great example of freezing is when you fill a glass of water and put it in the freezer. If you pull it out later it is ice. We talked about examples like when you boil water the molecules start moving faster until they escape the liquid atmosphere and turn into a gas. Another example of deposition is on a cold day if you look at your window there is water on it from the cold air outside and the warm air inside. Examples, liquid to solid: lava to stone, water to ice, salt water to crystals.

By: JAKE

| Start from | Change | Name |
|------------|-------------------------------|--------------|
| Solid | liquid | melting |
| liquid | solid | freezing |
| liquid | gas | boiling |
| gas | liquid | condensation |
| Solid | gas (skipping liquid phase) | sublimation |
| gas | solid (skipping liquid phase) | deposition |

SOLID LIQUID GAS

Phase changes happen as the temperature changes

What I Contributed

I contributed that the change from a liquid to solid is freezing.
 I challenged Daniel on if dirt floats is it really a gas?
 An example of boiling is when you put a pot of water on the stove and it turns into steam.

Knowledge Talk #1

0308.14.

In our knowledge our class talked about the three states of matter called Solids, liquids and gases. We learned that solids are usually hard because their molecules have been packed together. I now know that a solid can hold its shape unlike a liquid which fills the container it occupies. Some examples of a solid are - a diamond, a pencil or an apple. What I learned about a liquid is that a liquid is not easily compressible and it has little free space between particles. I also learned during the knowledge talk that liquid flows easily because it has no shape. The definition of a liquid is that liquid is the only state of matter with a definite volume but has no fixed shape. A liquid is made up of tiny vibrating particles of matter. Some examples of a liquid could be a bowl of soup or rain. What I learned about a gas is that gas assumes the shape and volume of its container like a liquid and the particles can move past along one another. Gas is compressible and can flow easily. Some examples of a gas is wind coming from a fan or smoke coming out of a fire place. The last thing we talked about is matter. Matter is anything that takes up space and has mass. Generally as the temperature rises, matter moves to a more active state.



Solid



Liquid



Gas

What Is A Force?

| | Roll a marble | magnet nail | elastic | math tile | erasing pencil marks | pendulum | balloon |
|-------------|---------------|-------------|---------|-----------|----------------------|----------|---------|
| gravity | | | | | | ✓ | |
| friction | ✓ | | | | ✓ | | |
| tension | | | ✓ | | | | ✓ |
| compression | | | | | | | ✓ |
| buoyancy | | | | ✓ | | | |
| magnetic | | ✓ | | | | | |
| elastic | | | ✓ | | | | |
| others | | | | | | | ✓ |

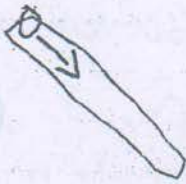
• The lego man floated when there was more water, but sank when there was less water.

• Pendulum = something that moves back and forth.

My Observations Journal

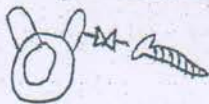
Tues. Jan. 21, 21

Roll A Marble



To do this experiment, we placed a metal ball on an inclined plane (a wooden metre stick) and let it go. It fell off a few times, but we kept it once. The force was friction.

Magnetic Nail



To do this experiment, each group got a magnet and a nail. Since both objects are metal and one's positive and one's negative they attracted in a magnetic force.

My Self-Assessment Log

My Self Assessment Log: Exit Ticket #1 : Structures and Mechanisms

Name: _____

Three things that I have learned about Structures and Mechanisms

1. The moon bridge is circular similar to the arch bridge.
2. A dead load is the weight of the bridge itself and a live load is the weight of the traffic.
3. Beam bridges are less expensive than other bridges.

Three things I am learning when I participate in Knowledge Building Talks

1. A tsunami can fill a 2 story building in 15 mins.!
2. Tornadoes can throw cars at between 62 m.p.h. and 207 m.p.h.!
3. Tornadoes can last from 1.2 seconds to over 1 hr.!

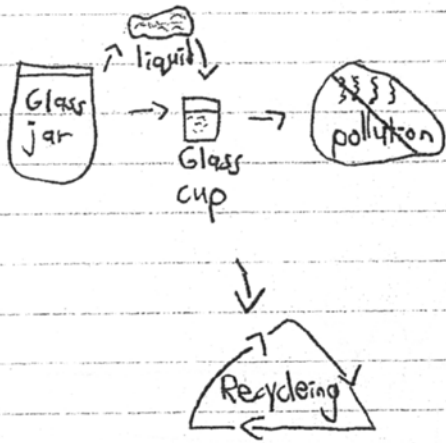
2 Ways I can connect what I am learning to the real world

1. I can connect back to when there was a tsunami in Japan (2011) flooded a 2-story building in less than 5 mins.!
2. I can connect back to when hurricane Sandy lasted over an hour.

My Strengths and next steps as a Knowledge Building Learning in Science :

1. ♥ = I get a lot of jot notes, making it easier for me to do my knowledge talk reflections.
2. → = I should participate more in knowledge talks because other people can get a lot of jot notes, making it easier for them to do their knowledge talk reflections.

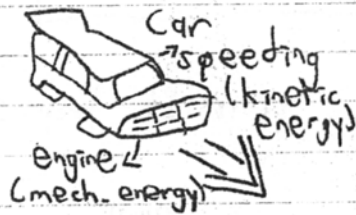
Picture Learning #5-05/08/14



This is an example of a thermoplastic because the glass jar can be remelted back into a liquid. It's also an example of recycle and how it helps us because when we burn glass jar, the liquid can be remelted into other glass object, which can cut down on pollution. If we keep the liquid in its state, its chemicals will smell up the air causing pollution. In real life, we recycle thermoplastics all the time, by throwing them in recycle bins. This cuts down pollution, too.

Excellent.

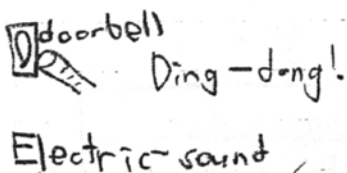
Picture Learning #1-05/15/14



This is an example of mechanical energy, because it's a mechanical object that can do work. It's also an example of kinetic energy, because the car is moving, just like kinetic energy. In real life, people use cars to get to far places, because most objects that contain mechanical energy are faster than the human body.

Excellent.

Picture Learning #2-05/23/14



This is an example of transferring energy because a door bell is powered by electricity and when you press it, it makes a loud noise, so electric energy is transferred into sound energy.

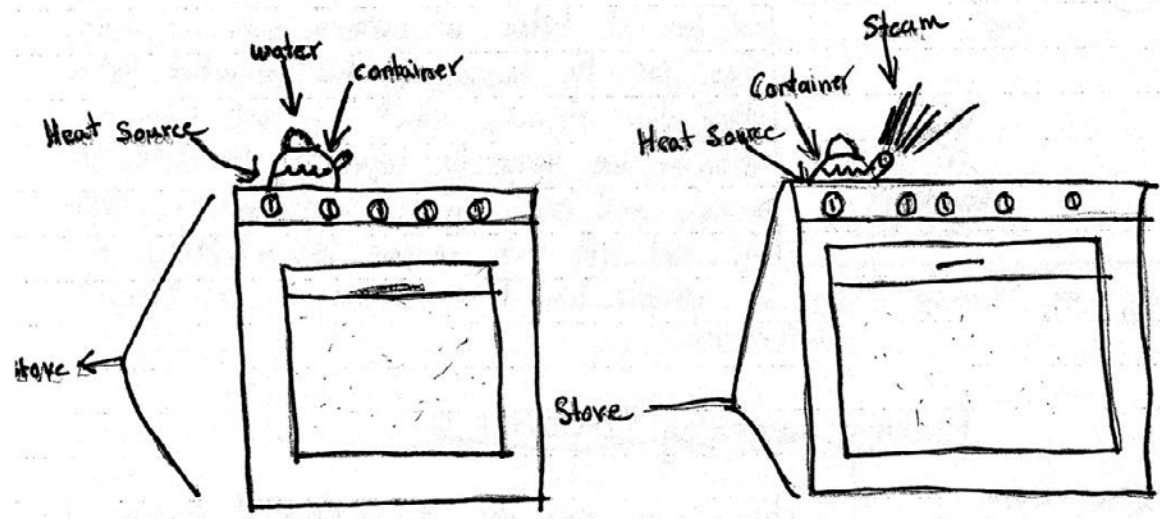
In real life, people have door bells so they can HEAR through the sound energy waves, knowing a person's at the door.

Excellent

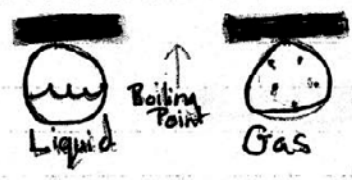
NOV 14 2014

Picture Learning Log

(Liquid) Water to (gas) Steam



Vapourization is a very interesting process. It happens when a liquid such as water is heated to its boiling point. From there, the molecules gain energy, and start moving faster and faster until they escape the liquid state and become steam.



When water reaches its boiling point, the phase of the liquid changes into a gas.

Different boiling points,

As you can see boiling points vary depending on the liquid and what it contains.

| liquid | Boiling point |
|---------------|-----------------|
| Water | 100 degrees C |
| Corn Oil | 246 degrees C |
| White vinegar | 100.6 degrees C |
| COKE | 100.2 degrees C |
| Gas | 110. degrees C |
| Blood | 124 degrees C |

Steps to Create an Electronic Portfolio

1. Select the 6 best notes within your specialty area. One note is defined as a cluster or group of notes.
2. The criteria for selecting 'best' notes are as follows:

Working at the cutting edge: Did the notes you selected...

- identify knowledge gaps and inconsistencies and formulate productive questions?
- generate a series of discussion (interest many people)?
- produced inquiry leading to the extension of community knowledge?

Progressive problem solving: Did the notes you selected...

- show continual efforts in grappling with problems posed by classmates; a cyclical process of problem formulation and resolution?
- deepening and sustained inquiry; showed evidence of the development, evolution, and improvement of an idea?

Collaborative effort: Did the notes you selected...

- help classmates and the community extend knowledge?
- make knowledge more accessible to community through summarizing various ideas and different perspectives?
- use scaffolds that 'put knowledge together' to bring together multiple lines of knowledge?

Identify high points: Did the notes you selected...

- result in an 'aha!' moment where you put knowledge together to create a new idea or problem to solve.
- recognize discrepancies and misconceptions; show new insights and different ways of looking at things?
- trace your own trajectory of understanding and knowledge building efforts?

3. The 6 best notes selected will include notes posed by yourself as well as your classmates.
4. Once you have selected your notes, you are to **write a summary /reflective piece for each note**. This acts to summarize the state of knowledge in your area of expertise. Start with a summary of the basics, e.g. 'what is a black hole?' or 'what is a string?' or 'what is quantum entanglement/teleportation'? Furthermore, your summary should include such things as debates between competing ideas, pros and cons of various ideas, experimental evidence supporting or refuting ideas. Include pictures and/or video that might help support your text (but NOT in place of it!). Be sure your pictures are visible within your portfolio by selecting highlighting your picture link then click on 'Object' then click 'show in place'.
5. Use the 'copy' function in Knowledge Forum to reference your summary work as you proceed.

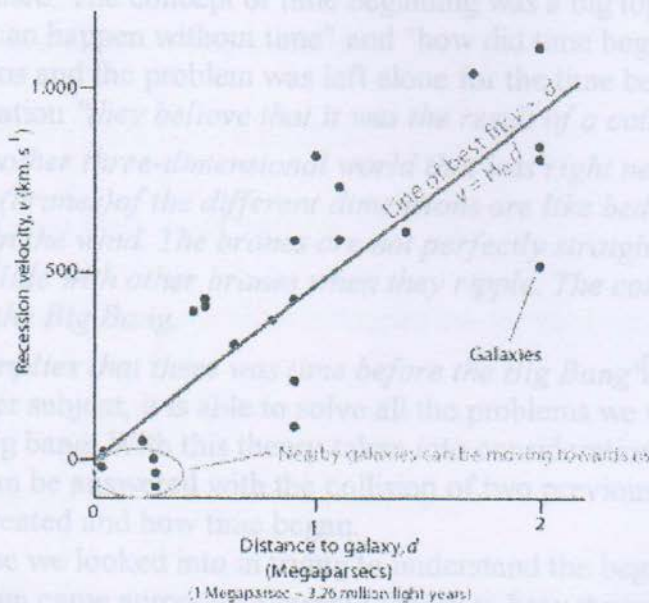
Understanding the Universe

1. The Beginning of the Universe

In terms of understanding the universe, one of the first questions that comes to mind is: how did the universe begin? As we researched we found that the most common and generally accepted theory that explains how the universe was created is the big bang theory. As Sarah found, (A definition "the universe started very small and very hot and expanded and cooled to the size and temperature of our universe today." ¹ Continue of definition). Basically the big bang theory is saying that the universe started as a singularity (Sarah found (A definition "These are zones in the universe that dont follow the laws of basic physics. They exist in the core of black holes and are areas with lots of gravitational force" ² Singularities)) and then expanded from there. After the big bang there was a period of rapid expansion, known as inflation, before the universe settled into the same slower expansion that we have today.

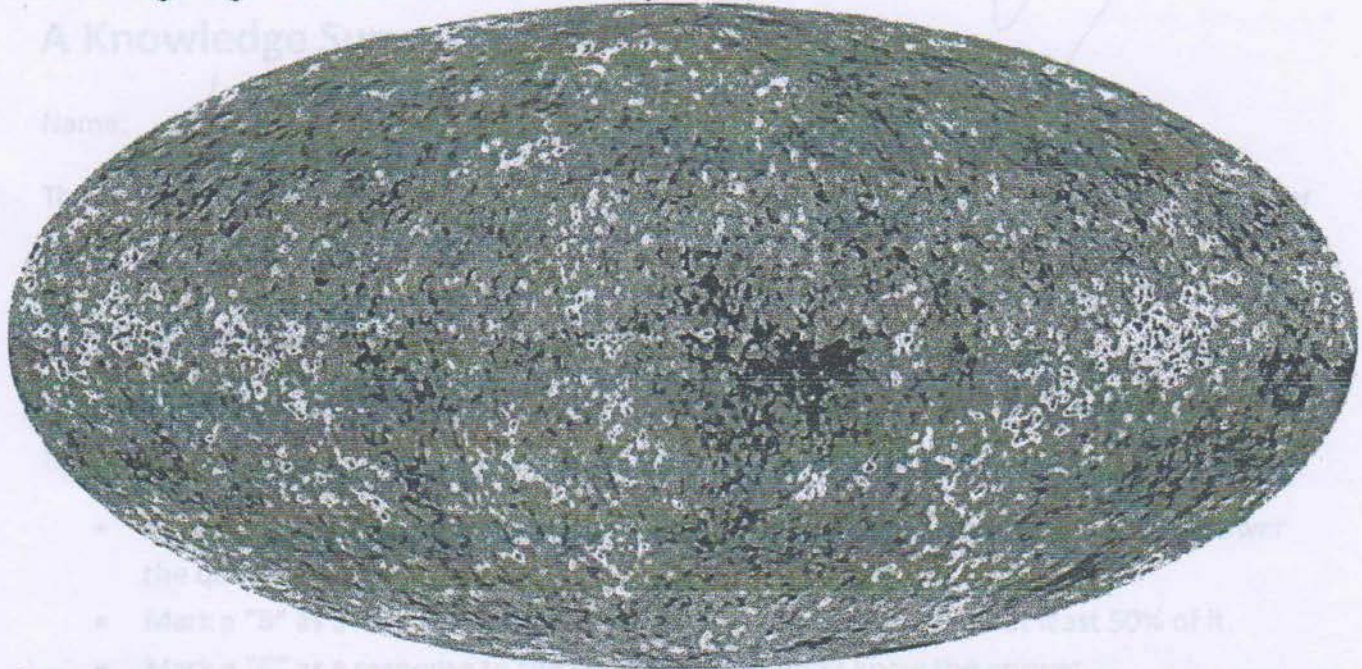
Even though this theory is generally accepted by most scientists we needed to find proof before making a decision. This is what led Alex to Hubble's Law, ("Here is some evidence..." "Hubble's law is his obsewrvtions that all objects observed in deep space are found to have a doppler shift observable relative velocity to Earth and to each other, and that this doppler shift-measuered velocity of various galaxies is proporcional to their distance from Earth. This basically means that on average, the more distant a galxy is, the faster it is recediung from us" ³ Hubble's Law) Alex also posted a graph that clearly shows that the galaxies are getting farther and farther apart from

Hubble's Plot of Galaxy Velocity & Distance



each other. (Picture with explanation This picture's line of best fit shows the the velocity at which distant galaxies are receding as a function of the distance to those galaxies. The galaxies are very clearly receding from us, and as Alex pointed out, ("Here is some evidence..." "if we go back in time the galaxies must have been closer together and thus a smaller universe. If we follow this pattern back far enough, it can be extrapolated that universe must have at one point been concentrated at a single point in space." ⁴ Hubble's Graph)

as a singularity, and is still expanding.) Hubble's Law proves that the universe is expanding without a doubt but it does not yet give the evidence needed to prove the big bang theory. Another piece of evidence that Sarah found is Cosmic Microwave Background (CMB). CMB is basically radiation from the big bang that we can still see to this day.



(Picture with explanation The different colours are temperature fluctuations from the big bang, with the red being the hottest, then yellow, then green, then blue. The red spots correspond with where the galaxies came to be. When scientists measured the radiation in the sky they found that the radiation comes from everywhere and with the same energy. This was exactly what was predicted would happen if the big bang actually happened.) Hubble's findings and the CMB images and radiation information help immensely in proving the big bang theory.

Something many of us were having trouble understanding at this point was the concept of 'before the big bang'. According to the big bang theory, there is no 'before' because time began with the big bang. We could not accept the concept that 'nothing' suddenly became 'everything' and time was suddenly created. The concept of time beginning was a big topic of discussion that all ended with "how things can happen without time" and "how did time begin". We were unable to find answers to these questions and the problem was left alone for the time being, until Alex posted something new,

(New information "they believe that it was the result of a collision between our three-dimensional world and another three-dimensional world that was right next to ours."⁵ Cosmic Collisions "membranes (branes) of the different dimensions are like bed sheets hanging on a clothes line that are blowing in the wind. The branes are not perfectly straight and flat and therefore different parts will collide with other branes when they ripple. The colliding ripples are what caused the matter after the Big Bang.

This theory implies that there was time before the Big Bang"⁶ Branes) Though Alex was posting this on another subject, it is able to solve all the problems we were having with understanding 'before' the big bang. With this theory taken into consideration, the questions like- what caused the big bang? - can be answered with the collision of two previous worlds. It gives the answer of how matter was created and how time began.

Something else we looked into in trying to understand the beginning of the universe was alternate

A Knowledge Survey in Modern Physics

Name: Savin Chene

This is a knowledge survey rather than a test. In a knowledge survey, you don't actually answer the questions or solve the problems provided, instead you evaluate the degree to which you have present knowledge to answer the question or address an item in the survey. The results from this survey do NOT count toward your grade.

To evaluate your knowledge, you will rate yourself on a 3-point scale described as follows:

- Mark an "A" as a response to the question if you feel confident that you could answer the question completely for test purposes.
- Mark a "B" as a response to the question if you can truly answer at least 50% of it.
- Mark a "C" as a response to the question if you don't know the answer.

If you mark an "A" or "B" that implies that you have significant background to answer a question, you should be confident enough that if asked to write down immediately what you know that you could respond and have it count for a grade.

Knowledge Survey on Black Holes

Before KB on Black holes.

1. How are black holes created?
A B C
2. How are black holes detected?
A B C
3. Why are black holes 'black'?
A B C
4. Describe how black holes influence the formation and structure of galaxies.
A B C
5. Explain the event horizon of a black hole.
A B C
6. Describe how black holes evaporate.
A B C
7. What happens when two black holes merge together?
A B C

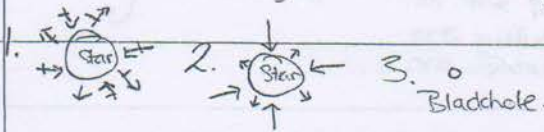
Same student...

After KIB on blackholes

2. How are black holes created?

A B C

Typically, stellar-mass black holes are created by large stars at the end of their life cycles. Stars are always emitting photons radiation. However when the helium within stars is used, carbon burning begins which creates iron as a by product. The heavy iron actually takes away energy/mass from the core. Normally, the outward radiation forces equal the inward gravitational pull of a star such that it can remain at equilibrium. However upon the decrease in mass of the core the outward radiation forces diminish. The core's temperature increases to try to remain at equilibrium, but as a result the outer layers of the star explodes outward - a supernova. The core compresses to a single point to immense density and gravitational pull - black hole. The larger the star, the greater the compression.



Small stars do not become blackholes but end neutron stars or white dwarfs as their cores collapse as much. Their electrons/neutrons maintain equilibrium to the inward gravity.

3. List and explain as many lines of evidence as you can on how we know black holes exist?

A B C

First, black holes, being mass, curve space-time. This means that although we cannot see them, black holes do cause gravitational lensing. By observing these bends in light we find that there must be mass. There is an equation to model the deflection angle of light caused by mass $\alpha = \frac{4GM}{c^2 b}$, with α the deflection in radians.

Furthermore we can observe how matter interacts around black holes. We see matter that appears to be falling toward a single point that point must be a black hole. For example, NASA created images to represent matter from a companion star being pulled toward a black hole. This representation is often seen in space.

Also, matter that falls inward emits x-ray radiation before passing the event horizon and after being ejected as jets from accretion disks. We can see these bright lights or jets and use the doppler shift to identify blackhole locations.

4. Why are black holes 'black'?

A B C

Black holes are 'black' because the collapsed core of the star is compressed to such a great density that the inward gravitational pull is greater than the speed of light. Thus, photons themselves are pulled into black holes, and as a result we cannot see anything without light.

Knowledge Survey

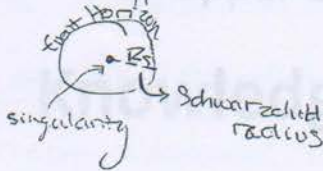
5. Describe how black holes influence the formation and structure of galaxies.

A B C

6. Explain the event horizon of a black hole.

A B C

The event horizon is a spherically or oval boundary (depending on the type of black hole) that is represented by Schwarzschild's equation. It is the point of no return as mentioned in previous questions. In a typical Schwarzschild black hole with no spin or electric charge:

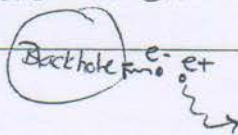


Anything that enters this theoretical boundary is unable to escape and pulled toward the singularity. Objects will experience spaghettification as the parts of the object closest to the singularity are pulled with a greater force than those that are further away.

7. Describe how black holes evaporate.

A B C

Since black holes have a finite mass, as per Hawking radiation they evaporate by losing 'energy'. Since energy is mass ($E=mc^2$), they lose mass and eventually evaporate. Around black holes electron-positron pairs (e^- and e^+) are constantly formed. Normally these would annihilate each other upon collision, however sometimes one of them escape. As a result mass/energy is lost. This is comparable to the Casimir effect which causes thermodynamic instability of black holes.



The lower the mass of the black hole, the greater its radiation and evaporation speed.

8. What happens when two black holes merge together?

A B C

9. Explain whether or not our Sun will become a black hole.

A B C

10. Describe where we find supermassive black holes.

A B C

11. What happens when you enter a black hole?

A B C

KNOWLEDGE BUILDING: A LIVING THEORY

KNOWLEDGE BUILDING: A LIVING THEORY

WHY KNOWLEDGE BUILDING, WHY NOW?

THE “INGENUITY GAP”

More and more, the social, economic and political well-being of modern societies will rely on the capacity of their citizens to be able to innovate and work creatively with knowledge across all fields (OECD, 2008). Complex, global problems such as climate change, economic downturns, and international political upheaval require a citizenry that can thrive in working with complexity and dealing with creative problem solving. Thomas Homer-Dixon (2000) has argued that the magnitude of global problems is incongruous with society’s capacity to tackle them; he conceptualizes this discrepancy as the “ingenuity gap,” that is, “the critical gap between our need for ideas to solve complex problems and our actual supply of those ideas.” From this perspective, the greatest limitation for solving complex, global problems is society’s capacity to innovate and generate novel solutions and ideas.

Alongside these broad concerns, there is also a strong moral imperative for immersing our students in authentic knowledge work from the earliest Grade levels. We know, for instance, that the level of knowledge students come into school with corresponds generally to the level that they leave school with. For example, possessing a greater vocabulary in primary school is one of the greatest predictors of reading and writing comprehension in future years (Stahl, 1991). Growing students’ capacity for knowledge work seeks to even the playing field and help to set all students up for success in our ever-changing world. Increasingly, the kinds of competencies that characterize knowledge creators — those 21st century skills like **effective collaboration, creativity, entrepreneurship, and the ability to work with complexity** — are qualities that are increasingly in-demand and will help lead to success and productive participation in society. The capacities for creative knowledge work also include social and collaborative skills that are built from a strong sense of empathy, open-mindedness and healthy communication habits; this in turn helps students develop themselves socially and emotionally as well as academically.

While there are many benefits to engaging young people in Knowledge Building, one of the most motivating for educators is that students love to do it. We’ve seen and heard many stories of once apathetic or bored students coming to life when they are given the chance to explore deeply a question or issue that they are truly interested in; of students who exhibited behavioural issues starting to come to school excited and engaged; of students who never perceived themselves to be “smart” light up when their ideas are taken seriously and valued by the classroom community. In the words of one KB student: *“I appreciate that there’s a community I can rely on, that I can focus on something I’m passionate about, and, it doesn’t feel like work!”*

WHAT IS KNOWLEDGE BUILDING?

If it had to be summed up in one sentence, Knowledge Building could be described as “**giving students collective responsibility for idea improvement.**” So, what exactly does this mean? Knowledge Building theory and practice is inspired by looking at how knowledge creating organizations of all kinds actually operate and how they create new knowledge out in the world. Knowledge creating organizations can appear in many shapes and sizes — from scientific think tanks, commercial design labs, a team of entrepreneurs, a network of software engineers, an artist collective, a community of Civil War historians — the list goes on and on. The knowledge artifacts these communities create take the form of designs, problem solutions, models, theories, services or products. While knowledge creating organizations represent a vast diversity of fields, the primary work of the members is to work creatively with ideas and produce knowledge artifacts that advance knowledge for the common good. In successful knowledge-creating organizations, innovation is not only the driving force, it is “part-and-parcel of the ordinary, if not routine” (Drucker, 1985). Research also tells us that while they can look very different, creative and innovative organizations share a variety of other common traits: they are comprised of members who can work creatively with ideas; they prize and cultivate a culture of trust, honesty, and risk-taking; they encourage diverse ways of thinking; they are non-hierarchical; and they nurture distributed leadership and expertise (Bielaczyc & Collins, 2005).

THE 12 PRINCIPLES OF KNOWLEDGE BUILDING

Knowledge Building is grounded in **12 Principles** that form the foundation of the pedagogy (Scardamalia, 2002). The principles can also be thought of as **the 12 habits of highly creative teams**. These principles represent the key qualities, traits and dynamics that characterize knowledge creation organizations of all kinds. They are framed to be directly applicable to educational contexts. Rather than dictate step-by-step procedures for teachers and students to follow, the principles are designed to be used as a tool to inspire innovative practice and a framework to evaluate practice and community dynamics. Because creative work with knowledge is not a linear or static process, the KB Principles represent flexible ideals that can be made manifest in a great variety of ways in many different contexts. In different sections of this manual, we engaged with each of the 12 Principles by elaborating briefly on their meaning and giving examples of practical applications that help bring them to life in the classroom.

ALL IDEAS ARE IMPROVABLE!

Knowledge Building puts ideas at the centre of classroom life. In Knowledge Building, ideas are treated as real things — they can be played with, modified, seen from different angles, spun off into other ideas, and grown over time (Scardamalia & Bereiter, 2003). Oftentimes, the generation of ideas can be the easy part of knowledge creation. When you're at the very beginning stages of a creative project or problem-solving journey, ideas can be a dime a dozen — this is as true in schools as it is in the world outside the classroom. But Knowledge Building is very much focused on “the hard part,” on moving forward in a promising direction from a wealth of ideas, and improving those ideas over time. **Idea improvement** is a foundational KB Principle, as well as a socio-cognitive norm that permeates the life and workings of a Knowledge Building community (Scardamalia, 2002). In KB, students are responsible not only for improving their own ideas but also for contributing to advancing the ideas and knowledge of the community as a whole. This represents a considerable shift in what students are typically expected to do in the classroom in a couple of ways. First, while it is true that in any educational program, students ought to come out with better ideas than they had going in, generally, it is the teacher who is responsible for recognizing misconceptions, designing tasks that will activate cognitive conflict, and evaluating results and performance in order to make idea improvement happen; on the other hand, in Knowledge Building, it is the students who are expected to increasingly take on these responsibilities themselves, with help and support from the teacher, technology, and their peer community (Scardamalia & Bereiter, 2014). Secondly, the imperative for every member of a classroom community to be contributing and advancing collective, public knowledge, as opposed to concentrating solely on their own individual learning, marks another major distinction between Knowledge Building and other educational approaches. We elaborate on these issues, first by expanding on the important distinction between ‘learning’ and ‘knowledge building’ processes, and then by discussing more closely the nature of public knowledge and collective idea improvement.

LEARNING AND KNOWLEDGE BUILDING: AN IMPORTANT DISTINCTION

Learning is a very different phenomenon than Knowledge Building and knowledge creation. There is both a theoretical and practical distinction between “learning” and “Knowledge Building.” Learning, on the one hand, can often refer to an internal and invisible process that goes on within an individual and is geared towards producing changes in individual belief or attitude; “learning by doing” is similar if the goal is to improve an individual’s skills at a particular task or performance (Scardamalia & Bereiter, 2002). Traditionally, most school-based practice focuses on learning. Knowledge Building, on the other hand, represents a distinctly different process. Three key differences can be pointed out:

- Whereas learning can be conceived of as a change in mental state, in contrast, knowledge creation/Knowledge Building produces **knowledge and ideas that have a public life**.
- While learning is an internal and invisible process, the improvement of ideas is “an **overt activity** that can within limits be planned, guided, motivated, and evaluated much like any other kind of work” (Bereiter & Scardamalia, 2014 p. 35-36).
- Knowledge Building refers to a **collective enterprise** as opposed to an individual mental process.

From a Knowledge Building perspective, learning inevitably occurs as a by-product of engagement in creative knowledge work.

KNOWLEDGE THAT HAS A PUBLIC LIFE

Creative knowledge work may be defined as work that advances the state of community knowledge, however broadly or narrowly the community may be defined (Scardamalia & Bereiter, 2006). So, what constitutes a collective knowledge advance? Any insight, idea, explanation, or improvement that represents new knowledge of value to the community itself.

Knowledge advances can take the form of giant leaps and breakthroughs, such as Einstein’s theory of relativity. However, these kinds of advances are rare indeed. Most often, idea improvement comes in small increments and contributions from many different people that all come together to advance the cutting edge of community knowledge. This collective effort is required for the advancements of public knowledge, which has a dynamic social life and changes over time. Everything from scientific theories to cars to historical accounts to smartphones have advanced due to the collective effort of professional communities dedicated to improving scientific, historical and technical ideas. As in the “real world,” students’ collective knowledge advances can take the form of big, breakthrough ideas or, much more commonly, of small incremental improvements in community knowledge. For instance, while it is true that any botanist can explain why leaves turn different colours in the fall, this knowledge is unknown to a group of Grade 1 Knowledge Builders. So, when students begin with simple theories about seasons changing and build onto these with more scientific concepts and ideas, they are building new knowledge. These kinds of advancements in the collective understanding of this natural phenomenon represent the authentic creation of new knowledge for this community.

Indeed, these kinds of knowledge artifacts represent the products of the knowledge creating organization’s collective intelligence — a type of knowledge that can only be described at the group level. For example, the knowledge demonstrated by an expert surgical team or by a successful sports team is a fundamentally collective phenomenon that equates to more than the sum of its individual parts (Stahl, 2006). Likewise, notions such as the “cutting edge of knowledge” or “intellectual property” are concepts that don’t represent the knowledge or genius of any one particular person, but rather the designs, theories, artifacts, models, etc., that live “out-in-the-world” and have a life of their own (Popper, 1972). For instance, in any academic discipline there is such a thing as the “state of the art” in the field. This state of knowledge does not represent

what every individual in the field knows, and not even what the most knowledgeable expert knows. Instead, this state of knowledge is, in every sense, “an emergent collective phenomenon, a distributed characteristic of the entire discipline” (Scardamalia & Bereiter, 2014, pg. 3). Ideas that have a public life and live out in the world can be taken up by knowledge workers at will and can be modified and extended by those who come after them. They can also serve as artifacts of the state of knowledge of a particular community long after that community no longer exists. As Marlene Scardamalia writes, “If we look back at prehistoric times, using archeological evidence, we can make out statements about the state of knowledge in a certain civilization at a certain time, without knowing anything about any individuals and what they thought or knew” (Scardamalia & Bereiter, 2014, p. 3).

CAN CHILDREN REALLY BE EXPECTED TO CREATE NEW KNOWLEDGE?

In the professional world, the scope of knowledge creation is typically defined by the organization’s particular kind of business or purpose. Members of these organizations come to them as competent knowledge creators in their fields — that is why they are hired or welcomed in the first place. However, education faces considerable challenges in these regards. First, knowledge creation in education is not limited to a specific field but “has the whole world of human knowledge as its intellectual workspace” (2014, pg. 36). Furthermore, teachers and students have to contend with certain situational constraints, including time limitations, content to cover, mandated tests, and more, that can impinge upon KB work. Certainly, adopting a principled Knowledge Building approach comes with many challenges. However, Knowledge Building pedagogy is based on the premise that authentic, creative knowledge work can take place in classrooms starting with the youngest students. Indeed, as the resources and examples cited throughout this resource shows, students across all Grade levels are able to engage in high-level knowledge work, given the right supports.

WHAT THE RESEARCH SAYS

So, what implications does this focus on collective knowledge have for teachers and students, for schools and classrooms? While group-level knowledge and performance is the norm in many professional contexts, and especially in knowledge creating organizations, schools remain primarily responsible for individual students’ learning, and for what individual students take from educational activities. Individual achievement can and ought to be evaluated separately from collective knowledge advances. Indeed, it is impossible for a student to be participating in authentic knowledge creation and not be learning at the same time.

A long standing and growing body of research demonstrates the positive effects of Knowledge Building on student achievement. Below is a very short list of select studies highlighting key research findings:

- **Individual learning of content knowledge:** evidence shows that participating in group Knowledge Building efforts enhances individual student learning in subject matter (Scardamalia et al., 1992; Chuy et al., 2010; Zhang, Scardamalia, Reeve, & Messina, 2009).
- **Domain-specific literacies:** Research shows gains in enhancing subject-specific literacies including but not limited to scientific literacy, (e.g., Caswell & Bielaczyc, 2002; Lee, Chan, & Aalst, 2006; van Aalst & Chan, 2007); mathematics (Moss & Beatty, 2006; Hutton, Chen, & Moss, 2013; Moss & Beatty, 2010); and historical inquiry (Resendes & Chuy, 2010). Research also shows KB effecting student gains in engineering, language arts, chemistry, phys. ed., social studies, and the arts (see Chen and Hong, 2016 for an overview).
- **Epistemic literacies:** Studies found KB helped students move from a view of scientific knowledge as fixed, factual, and objective towards a deeper understanding of the nature of the theoretical (Bereiter & Halewood, 2015) with an underlying connection found between vocabulary development and conceptual understanding (Sun, Zhang, & Scardamalia, 2008). Research has also shown gains in vocabulary and comprehension as by-products of collaborative Knowledge Building work with no direct focus on vocabulary learning and text comprehension (Scardamalia et al., 1992). A longitudinal study following a student cohort engaging in over 6 years of KB writing showed significant growth in productive writing vocabulary (Chen, Ma, Matsuzawa, & Scardamalia, 2015).
- **Graphical literacy:** Research suggests KB can also support graphical or visual literacy, which precedes and enhances reading and writing (Sinatra, 1986; Gan, Scardamalia, Hong, & Zhang, 2010; Oshima & Scardamalia, 1996).

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