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 travel in straight lines (box with powder and shadow experiments) and wavy lines (Thomas Young experiment)." — *Grade 4 Knowledge Builder*

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, to 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. 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 (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

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

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

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

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 to prior to the first KB Circle. Teachers find issues will disappear as students discover their contributions and voices are valuable to the community.

When should we do a KB Circle, and for how long?

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 as a full group consistently to share insights and ideas as a whole community — a valuable and essential cultural norm to establish in a Knowledge Building classroom. It is also critical that students be encouraged to use the KB Scaffolds to structure their KB Circle conversations and keep the focus 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 learnteachlead.ca (https://vimeo.com/108100267)

Coming Soon! "Knowledge Builders" KB Podcast Series: A four-part series exploring innovation and knowledge creation in a Grade 8 classroom. Listen for how the teacher uses KB Circles in his ideas-driven classroom!

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 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. 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 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!

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.

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. **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, 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 as a note (Knowledge Forum [KF] is the online platform used to support Knowledge Building work. See pgs. 80-91 to explore how to use this technology.) but was not given much attention by others. The teacher intentionally re-introduced it 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, human, 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!

Sustaining Momentum: Idea-Centred Classrooms

THE THEORY: Knowledge Building starts with the inherent natural curiosity of the child and extends to *unnatural 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 support 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, use of Knowledge Forum** (collaborative technologies).

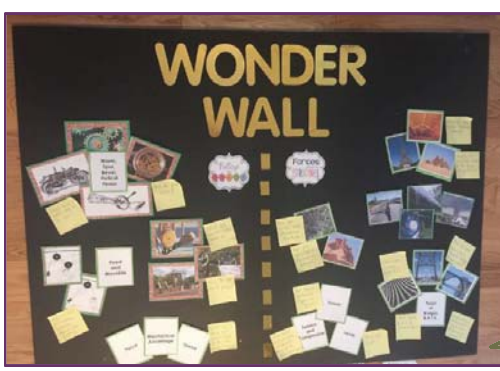
"Historically, throughout the world, and across decades and millennia, ideas have been improved. So kids get this sense of, 'Oh! Einstein's idea was improved. If Einstein's idea can be improved, so can mine!' So…it's not "I was naive, or I was wrong"…but it's so natural to improve ideas." — Marlene Scardamalia

> "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 curiousity about your classroom KB work throughout the whole school community.

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 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 [www.thelearningexchange.ca]).

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

In Photo 1 on the previous page, two of the Big Ideas from the Grade 6 curriculum Biodiversity unit are posted at the very top and create the framework for the KB Wall. Three major themes are identified on the larger yellow strips: *Interrelationships; Local and Global Issues; 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.

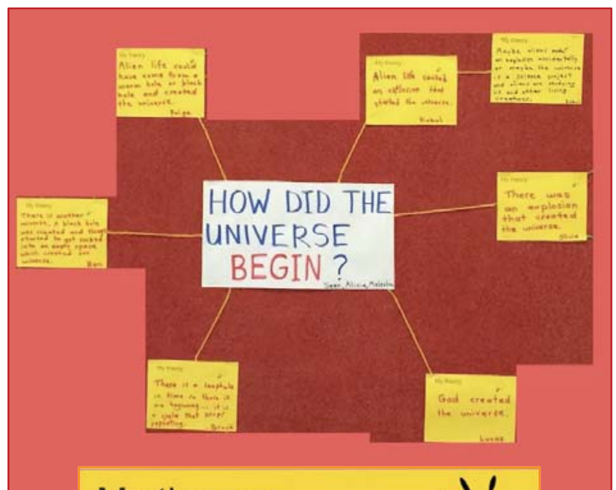
Photo 2 on the previous page shows another KB Wall focused on Geography. The central question focused on exploring how and why landforms change. Coloured paper squares are labelled with various KB Scaffolds and made available in baskets in the classroom for students to use (see Photo 3). The scaffolds 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.

1. 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" (see Figure 1).

2. Next, students engaged in active research to explore the plausibility of these theories. As seen in Figure 2, as students investigated, 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



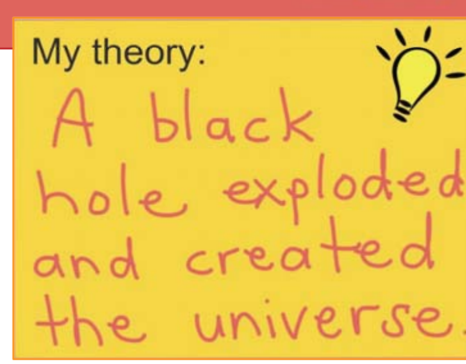


Figure 1. The first step to creating a KB Wall includes posting a question or problem and adding original theories on yellow colored paper.

indicate connections between ideas and build-on contributions.

3. 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 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 and integrated ideas to get to new insights, more sophisticated ideas and higher and higher level understandings.

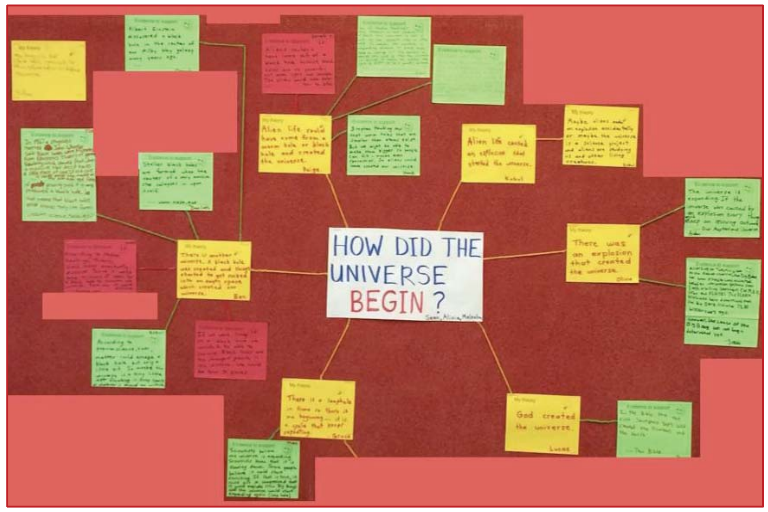


Figure 2. Students add on their "Evidence to Support" (green paper) and "Evidence to Discount" (red paper) contributions

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 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. 401-43), they decided to continue their investigation using Knowledge Forum, which afforded them infinite space in which 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. 80-91).

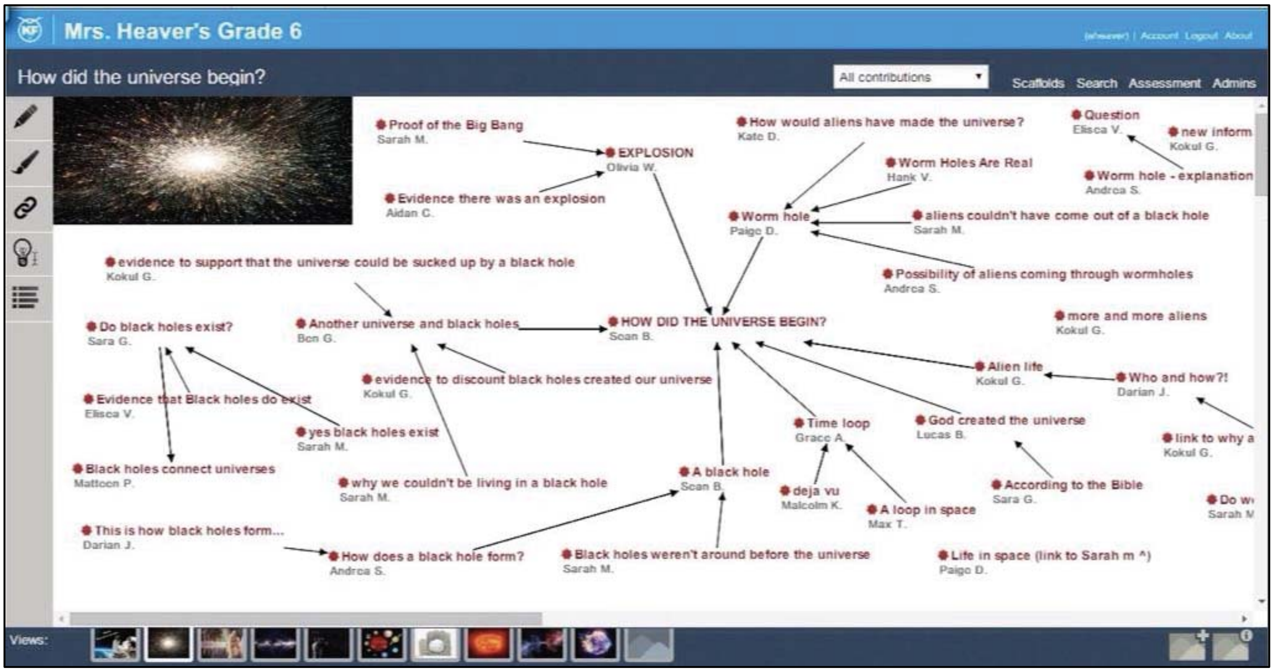


Figure 4. A Knowledge Forum "view." Red dots indicate student notes, red text are note titles that can be double clicked and opened to reveal note contents (see below).

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?

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 47-49 of this resource tells the story of class of Grade 6 Knowledge Builders exploring biodiversity and helps to illustrate what an idea-centered KB class looks like, where tasks and activities are undertaken in service of the organic evolution of students' ideas.

"If your road to success is pretty straight, you didn't challenge yourself!" — *KB student*

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, and needs 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:

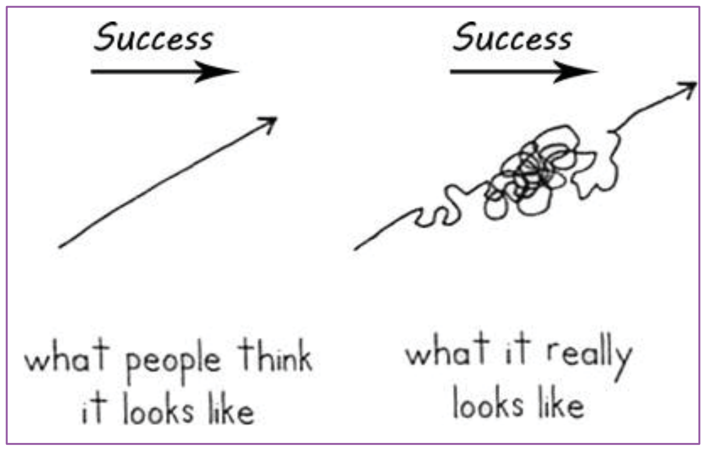


Image attributed to: Dimitri Martin (2011), *This is a book*. Grand Central Publishing.

- **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**
- **Observing and recording observations**
- **Designing and conducting experiments**
- **Investigating and evaluating primary sources**
- **Organizing work and setting priorities, such as planning next steps, setting and revising goals**
- **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?** Give students time and opportunity to make promisingness judgments on their ideas as a way to help move the 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. Step: 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. We will have to sacrifice another feature (can't be as cost-efficient, as aesthetically pleasing, needs to be thinner or shorter, etc.); we simply can't; 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: 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.

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 2) Feasibility of implementation. Each box is colour coded. The blue box represents "blue sky" ideas; the purple box represents exciting and innovative but feasible ideas; the green box represents less creative ideas 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.

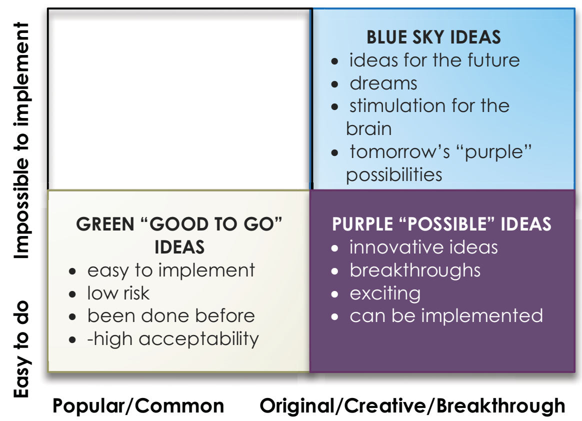


Figure 6. How! Wow! Now! Matrix

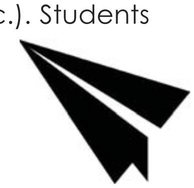
Example:
Students are working on a way to increase awareness in their community about how many families rely on food banks and donations in their area and on how hunger and poverty impact students' achievement in school. They have lots of ideas of ways to get involved in the issue, to educate the community, 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 (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, talk 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 return 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. 75-79) 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 or understandings?

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 these 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 [www.thelearningexchange.ca]).

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 (e.g., it grows, it can move, it reproduces, it needs water, oxygen, 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 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.)

The Grade 6 “KB Wall” exploring the big question “How do we know if something is living?”

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 H_2O meant water contains hydrogen and oxygen; a student knew about CO_2 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.

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.*