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 and 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 of 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, but 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 the **12 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.** 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 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 grow 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:

1. 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**.
2. 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).
3. Knowledge Building refers to a **collective enterprise** as opposed to an individual mental process.

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. 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. 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.

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. From a Knowledge Building perspective, learning *inevitably* occurs as a by-product of engagement in creative knowledge work. 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 process, theory-fact differentiation, and recognition of the role of ideas in scientific progress (Caswell & Bielaczyc, 2002; Lam & Chan, 2008; Carey & Smith, 1993).

Basic literacies: Research shows positive effects on reading development across Grades 1-8 (Scardamalia et al., 1992; Haneda & Wells, 2000) as well as gains on the development of reading and writing skills of students as young as 4 and 5 years old (Pelletier, Reeve, & Halewood, 2006).

Writing and vocabulary: Studies exploring student writing in KF show growth in both domain-specific and academic words (Sun, Zhang, & Scardamalia, 2010; Resendes, Chen,

Scardamalia, 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 KF 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).