Natural Curiosity:

A Resource for Teachers

Building Children's
Understanding of the World
through Environmental Inquiry

"This is obviously the way that teaching and learning should happen." - Dr. David Suzuki

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UNIVERSITY OF TORONTO

The Laboratory School at the Dr. Eric Jackman Institute of Child Study
OISE | ONTARIO INSTITUTE FOR STUDIES IN EDUCATION

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Elizabeth Morley
Principal,
The Laboratory School
Dr. Eric Jackman Institute of Child Study

Preface

Making the Shift to Environmental Inquiry

> *"The skills, aptitudes, and attitudes necessary to industrialize the earth are not necessarily the same as those that will be needed to heal the earth."*
> – David W. Orr, *Earth in Mind: On Education, Environment, and the Human Prospect* (2004)

As ecologist and scholar David Orr emphasizes, our ability to restore planet Earth rests primarily on the decisions we make about education. The kind of education which has given us the "skills, aptitudes, and attitudes necessary to industrialize the earth" is no longer practical given the vulnerable state of our natural world. Resource depletion, loss of species, and climate change threaten the sustainability of the planet. Orr suggests that we need a fundamental shift in the way we think and behave, a shift made possible by a fundamentally different approach to teaching and learning: Education that nurtures children's innate curiosity about the natural world, that fosters their understanding of the interconnectedness of all living and non-living things, and instils in them an abiding sense of care and responsibility for the well-being of their communities and planet Earth.

But what does this kind of education look like? What kinds of skills and practices are necessary for a shift like this to occur? How do teachers nurture children's sense of wonder such that they develop a lasting appreciation for the natural world? And how do teachers empower children to contribute to their own learning and development, rather than passively accept the status quo, educational, environmental or otherwise?

These questions are fundamental to our role as teachers. They prompt us to re-examine our practice – to rethink what we do and why we do it. They invite us to imagine, for a moment, teaching and learning that looks like this:

Imagine children who continually question why things look and function the way that they do. Where their natural sense of wonder is at the centre of their learning and informs the direction it will take. Where children's formative conceptions are welcomed as opportunities for idea improvement. Where knowledge is dynamic, collectively constructed, and informed by many sources instead of ensconced in a single textbook, adult or classroom. Where information is investigated, analyzed, and negotiated between students. Where children are invested in the learning process because they have been given a key role in directing how and what they will learn. Where children learn from each other. Where the teacher learns from the children. This is **Inquiry-based Learning**.

Now, envision that kind of learning as a seamless, cohesive whole, where children's questions cross disciplinary boundaries. Where children draw upon Language, the Arts, Math, Science, and Social Studies to both improve and represent their understanding of different aspects of the environment. This is **Integrated Learning**.

Next, picture children playing, building, researching, and designing experiments that test their current understandings. Imagine them venturing outside their classrooms to learn about nature in nature, gaining a full sensory experience of their natural surroundings, making close observations, and recording and reflecting on their

findings. This is **Experiential Learning**.

Finally, imagine children who have developed a caring relationship with the natural world, who have been given the time and opportunity to experience it in meaningful ways. Imagine children who have a growing commitment to protect water, air, plants, and wildlife because they understand that these occupy an important place within the ecosystem. Imagine students who, through the Inquiry process, gain the confidence and sense of empowerment to effect change that will benefit both their communities and the environment. This is **Stewardship**.

Inquiry-based Learning, Integrated Learning, Experiential Learning, and **Stewardship**: Taken together, this four-branch approach to teaching is called Environmental Inquiry.

About this Resource

Why a Resource on Environmental Inquiry?

The current environmental crisis can serve to remind us about the purpose of education: To develop knowledgeable and responsible citizens who are committed to the well-being of their communities and to the world at large. Teachers who make the shift to Environmental Inquiry are better able to guide their students along that path because this four-part approach has an innate potential to elicit students' natural curiosity about the world and to create a classroom culture of learning that is purposeful, fun, productive, and responsive to students. When a student's imagination is engaged, his or her learning naturally blossoms. When the same happens for the teacher, his or her practice is transformed.

There is an obvious connection between what the Ministry of Education is asking of teachers in Ontario and the decades of evidence-based practice at The Dr. Eric Jackman Institute of Child Study. The Ministry's policy framework on Environmental Education, as articulated in *Acting Today, Shaping Tomorrow* (2009a), embraces the branches of Environmental Inquiry: ***Inquiry-based Learning, Integrated Learning, Experiential Learning, and Stewardship***.

The Ministry's policy not only strengthens Ontario's public education system, it opens the way for teachers across the province to explore the possibilities of Environmental Inquiry in their classrooms. However, many teachers worry that this new policy framework means that they are expected to add yet another subject, Environmental Education, to an already burgeoning curriculum. They may wonder how much they need to learn about the environment in order to teach it, and whether their workload will be tipped to the breaking point. And if they get past all of those concerns, they may rightly ask: ***"How do I turn Environmental Education policy into practice? What exactly does this entail?"***

> *"Ontario's education system will prepare students with the knowledge, skills, perspectives and practices they need to be environmentally responsible citizens. Students will understand our fundamental connections to each other and to the world around us through our relationship to food, water, energy, air, and land, and our interaction with all living things. The education system will provide opportunities within the classroom and the community for students to engage in actions that deepen this understanding."*
>
> Ontario Ministry of Education, *Acting Today, Shaping Tomorrow: A Policy Framework for Environmental Education in Ontario Schools* (2009a)

This resource is intended to help you, the teacher, bridge the "what" of Ministry policy to the "how" of practice. It demonstrates how Environmental Inquiry can enable you to meet, and even exceed, Ministry expectations while transforming your practice into a more enjoyable, creative, and productive experience. This book presents a sustainable approach for teachers to use in achieving professional accountability and greater personal satisfaction.

About the Dr. Eric Jackman Institute of Child Study, University of Toronto

Established in 1925, the Dr. Eric Jackman Institute of Child Study is part of the Department of Human Development and Applied Psychology (HDAP) and the Initial Teacher Education (ITE) program at the Ontario Institute for Studies in Education (OISE), University of Toronto. The Dr. Eric Jackman Institute of Child Study is dedicated to improving the lives of children through its two-year MA program in Child Study and Education, The Laboratory School (Nursery to Grade 6), and The Dr. R. G. N. Laidlaw Centre for multidisciplinary research in child development.

Organization of this Resource

Part 1: Environmental Inquiry: A Pedagogical Framework

This resource is made up of two main parts. Part 1 is a detailed section devoted to each of the four branches that comprise Environmental Inquiry: **Inquiry-based Learning, Integrated Learning, Experiential Learning,** and **Stewardship**. These four parts are presented in a consistent order throughout this resource to help the reader navigate the content. However, Environmental Inquiry is not necessarily a linear or sequential process. For example, a class' outdoor experience may be the spark that ignites their curiosity, leading to questions that set the wheels of Inquiry-based Learning in motion.

The benefits and the practical implications of Environmental Inquiry are also discussed. Examples include:

- the role of the teacher
- student engagement
- curriculum expectations
- what children's questions reveal
- responsive and flexible planning
- student assessment, evaluation, and reporting

Part 2: Environmental Inquiry in Action: The Teachers' Stories

Part 2 describes the experiences of teachers who have integrated Environmental Inquiry into their practice. It includes the stories of four teachers at The Lab School as well as those of seven teachers at four public schools in Toronto: Victoria Village Public School, The Grove Community School, Our Lady of Fatima Catholic Elementary School, and Rose Avenue Public School.

What is Environmental Education?

"Environmental education is education about the environment, for the environment, and in the environment that promotes an understanding of, rich and active experience in, and an appreciation for the dynamic interactions of:

- *The Earth's physical and biological systems*
- *The dependency of our social and economic systems on these natural systems*
- *The scientific and human dimensions of environmental issues*
- *The positive and negative consequences, both intended and unintended, of the interactions between human-created and natural systems."*

Working Group on Environmental Education, *Shaping our Schools, Shaping our Future* (2007)

These stories reveal how different teachers (at different grade levels and with diverse groups of students) organized broad key concepts within the curriculum to create a learning environment conducive to:

- student questioning and theorizing
- student investigation and discourse
- identifying cross-curricular links
- supporting student-driven initiatives in environmental stewardship

A fundamental principle of Environmental Inquiry is the centrality of the learner: the importance of taking into account the student's unique learning style, cultural background, interests, and developmental needs. These stories are offered as *examples* of what Environmental Inquiry can look like in practice, not as blueprints for lesson plans or units of study. Their primary function is to give the teacher a sense of the mindset and essence of this approach, an idea bank for getting started. They are meant to encourage teachers to consider how Environmental Inquiry might work in their own classrooms.

Teachers New to Environmental Inquiry: "Yes You Can!"

Teachers can choose how best to integrate Environmental Inquiry into their practice. Some may choose to begin with a few basic steps to test the waters. Others may decide to go full-tilt, to try as much as possible all at once. How much one does or how far one ventures is not important. What matters is that a shift is made and that the experience is both positive and productive. Susanna Chwang, Grade 1/2 teacher at Rose Avenue Public School, offers this advice to teachers new to Environmental Inquiry: *"I hope teachers reading this resource realize that they can take this system and make it their own. Even if you're only able to take just the first few steps, getting students to make decisions about their own learning is of great importance".*

The teachers who participated in the Environmental Inquiry Pilot Project were highly motivated. They wanted to grow professionally and to deepen their students' understanding of the environment. Many expressed the desire to "think outside the box" and to break the monotony of "doing everything the same way, year after year".

Admittedly, these teachers were initially anxious about embarking on what seemed to be a new adventure. They asked numerous questions at the outset including: *"How do I elicit my students' curiosity? How do I ensure that I address the curriculum while allowing the students to shape the direction of their own learning? How do I plan for Environmental Inquiry? What about student evaluation?"*

Such concerns soon fell by the wayside as these teachers began to experience the benefits of Environmental Inquiry, including their ability to meet or exceed Ministry expectations. *"I'm a lot happier teaching this way,"* says Perri Evert, Kindergarten teacher at Victoria Village Public School. *"Doing it through the questioning and the ideas that the kids have just covers so much in a deep way. We meet more curriculum expectations this way than if I were teaching solely in a more traditional teacher-directed way."*

These teachers were quite literally taken by surprise. They have expressed gratitude, delight, excitement, and relief to discover that Environmental Inquiry, even when practiced in its most preliminary form, can be effective. The new approach has energized their teaching, engaged their students, and transformed their classrooms into exciting learning environments.

Part 1

Environmental Inquiry: A Pedagogical Framework

Introduction

What is Environmental Inquiry?

Environmental Inquiry* is an overarching approach to Environmental Education* that integrates Inquiry-based Learning*, Experiential Learning*, Integrated Learning*, and Stewardship* into a dynamic and cohesive pedagogical framework.

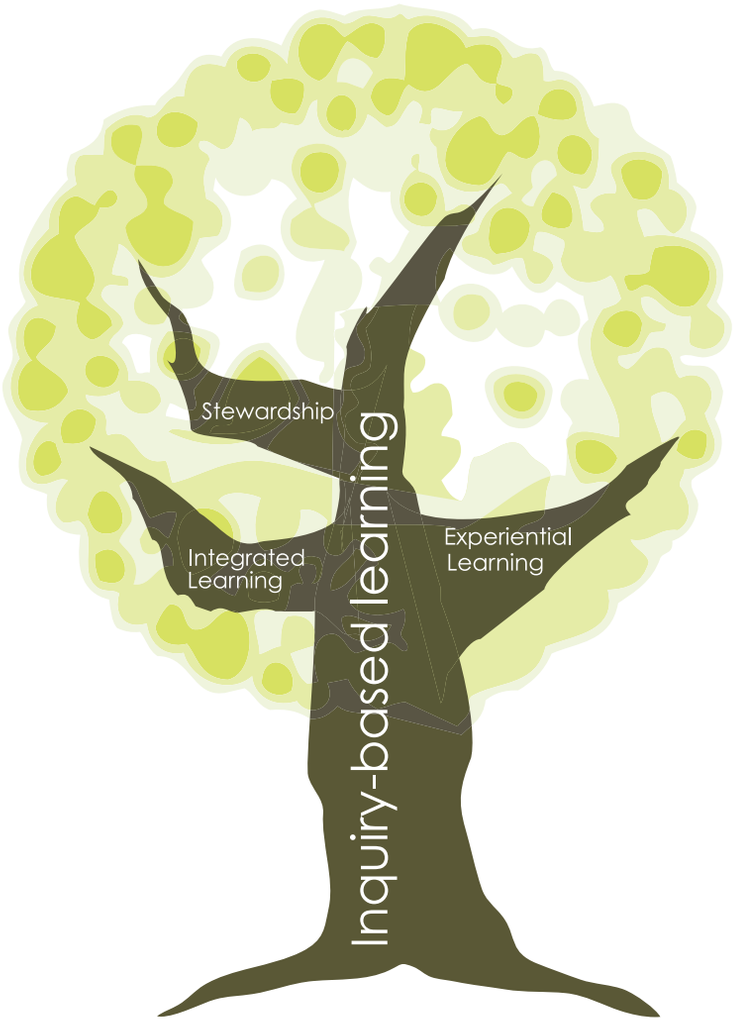
The full potential of Environmental Inquiry cannot be attained unless inquiry-based learning principles are present. For example, a class studying biodiversity may take a field trip to a conservation area in the spirit of Experiential Learning. However, unless the students have the opportunity to thoughtfully reflect on their experience of that trip, to make connections with previously held beliefs or to pose new questions that they will later pursue, then the full potential of Environmental Inquiry is forfeited.

In contrast, when the principles of Inquiry-based Learning are consciously considered, the potential of Experiential Learning, Integrated Learning, and Stewardship is both informed and enhanced. In turn, the latter three branches spark new iterations in Inquiry-based Learning, propelling children's learning deeper into the Environmental Inquiry process.

About this Chapter

This chapter sets forth the pedagogical framework for Environmental Inquiry and is organized into four subchapters, each of which corresponds to one part or branch of Environmental Inquiry (e.g., a subchapter on Experiential Learning). Each subchapter contains two sections, "Theoretical Underpinnings" and "Putting it into Practice," and provides cross-references to teachers' stories (in Part 2 of this resource) to help the reader visualize various aspects of Environmental Inquiry in practice.

Figure 1: Environmental Inquiry



* For the purposes of this resource, these terms are used as proper nouns when they refer to an actual instructional approach (i.e., not when they function as adjectives).

Branch I: Inquiry-based Learning

Nurturing a Sense of Wonder

> *"I should ask that a gift to each child in the world be a sense of wonder so indestructible that it would last throughout life, as an unfailing antidote against the boredom and disenchantments of later years, the sterile preoccupation with things that are artificial, the alienation from the sources of our strength. . . If a child is to keep alive his inborn sense of wonder, he needs the companionship of at least one adult who can share it, rediscovering with him the joy, excitement, and mystery of the world we live in."*
> – Rachel Carson, *The Sense of Wonder* (1998)

1. Theoretical Underpinnings

Curiosity is Natural!

Humans are innately curious beings. From birth, they behave in ways that demonstrate an 'instinct' for inquiry, a natural capacity and desire to learn about their environment (National Science Foundation, 2001). Babies rely upon their senses as they explore the concrete, observable aspects of their immediate surroundings. Their world is full of wonder and newness. They gaze at faces, put objects into their mouths, respond to voices and sounds – all to gain more experience and information (Thornton, 2003, as cited in Ogu & Schmidt, 2009).

As children acquire and develop language skills, they build upon this foundation of sensory-based inquiry. Quite naturally, they begin asking questions about the many things they see, hear, feel, taste, and smell in their environments, both natural and built. Their curiosity seems insatiable, the process of learning natural and unstoppable.

However, as Rachel Carson notes, a child's sense of wonder can be lost or diminished, and with it, the desire to learn. Through an inquiry-based learning approach, teachers have the opportunity to nurture students' natural curiosity and their ability to be fully-engaged learners throughout their lives.

What is Inquiry-based Learning?

A dynamic process

Inquiry-based Learning is a dynamic and emergent process that builds on students' natural curiosity about the world in which they live. As its name suggests, Inquiry places students' questions and ideas, rather than solely those of the teacher, at the centre of the learning experience. Students' questions drive the learning process forward. Teachers using an inquiry-based approach encourage students to ask and genuinely investigate their own questions about the world. Teachers further facilitate students' learning by providing a variety of tools, resources, and experiences that enable learners to investigate, reflect, and rigorously discuss potential solutions to their own questions about a topic the class is studying.

A pedagogical mindset

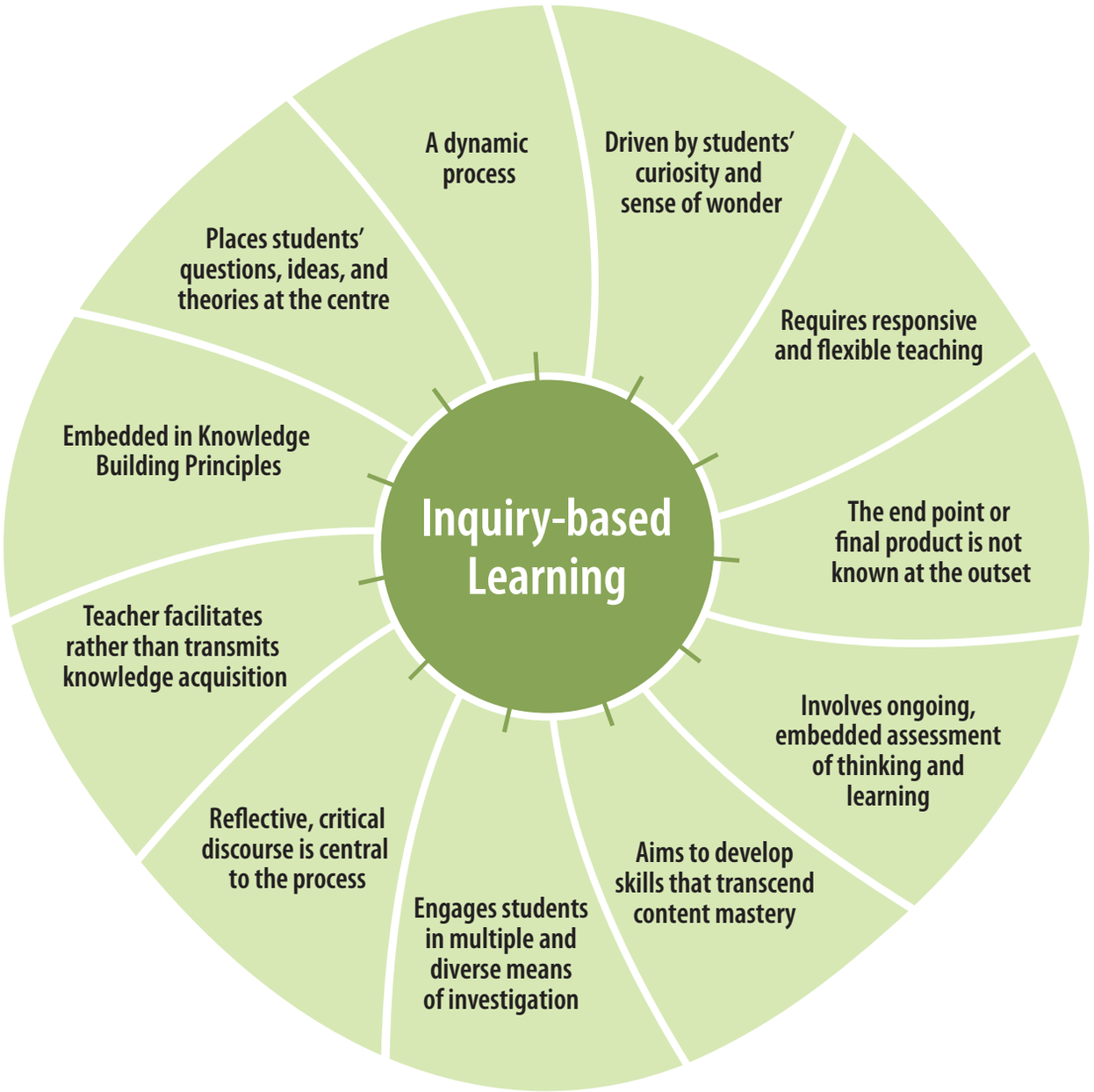
The inquiry-based approach is not a rigid methodology or set of procedures. Rather, it entails an overall mindset, one that pervades school and classroom life to foster a culture of collaborative learning and idea improvement. Teachers continually encourage students to contribute their ideas and engage in critical problem-solving processes in a variety of contexts, whether curricular or social.

The *process* of student learning, more so than the teacher's focus on 'covering the curriculum' is paramount. By encouraging active learning,

teachers enable students to deepen their understanding of the content in a manner appropriate to their needs and developmental stages. Thus, a teacher might provide an open-ended respond to a student's question such as, "How can we find that out?" Further, if the student appears to need time and space to work out his or her ideas, the teacher might say, "Tell us more about this after you have had some time to think about it".

One can think about Inquiry-based Learning as a continuum that moves from closed to open. The more teacher-directed the learning, the more closed the inquiry. The more student-directed the learning, the more open the inquiry. At The Laboratory School, teachers try to facilitate open inquiry wherever possible. Making the decision to do this requires what some teachers have described as a "leap of faith", a sense of trust and confidence that this new way of thinking and doing will lead to valuable learning for their students. Marlene Scardamalia, co-founder of the Institute for Knowledge Innovation and Technology (IKIT) likens this shift to a Copernican Revolution, "much like moving the sun from the periphery to the centre" (2000, p. 5).

Figure 2: Defining Characteristics of Inquiry-based Learning at The Laboratory School



Why Take the Leap? The Benefits of Inquiry-based Learning

Whether they have been teaching through Inquiry for several years or several months, teachers agree that Inquiry-based Learning offers far-reaching benefits for students. Some of the major benefits include, but are not limited to the following:

1. **Honouring students' questions increases their motivation, leading to higher levels of engagement, improved understanding, and a love of learning.** A student who asks a question is essentially providing the teacher with information about what he or she is interested in knowing, or his or her level of understanding. A student's interest in the content profoundly affects his or her attentional and retrieval processes, acquisition of knowledge, and effort expenditure. Students engage deeply with the content because it interests them, not because they are expected to learn it. Consequently, their learning is superior: They use more elaboration strategies, seek more information, and reflect more on the material (Hidi, 1990).

2. **Inquiry stimulates students' curiosity, leading to progressively deeper questions and habitual critical thinking.** By fostering a culture of inquiry, teachers help students become more discerning observers and thinkers. Critical-thinking skills deepen and become habitual. Curiosity is cultivated and preserved – and for good reason. As David Orr (2004) cautions, "the sense of wonder is fragile; once crushed, it rarely blossoms again" (p. 24). The consequences are abysmal: students eventually stop noticing and asking questions and, by default, resort to the 'game' of education, which simply includes figuring out what the teacher wants to hear and what will be on the test.

3. **Inquiry builds lifelong learning skills that transcend content mastery.** We live in an age of information-overload and rapidly-changing technologies. Access to content knowledge is literally at students' fingertips. However, information accumulation is no longer the primary objective of education. Students in the 21st century need to acquire skills for deciphering what information is useful and what is not.

   Through Inquiry, students develop skills which they can apply to all content areas and across all grade levels, including: reflecting on the purpose, meaning and process of accumulating various types of information, interpreting information and reconciling it with personal beliefs, articulating ideas clearly and effectively, posing questions to help clarify multiple points of view, and respecting the diverse contributions of individuals within a collaborative group (Partnership for 21st Century Skills, www.p21.org).

The Role of Knowledge Building (KB)

Knowledge Building pedagogy refers to teaching and learning approaches that:

- are based on fundamental guiding principles rather than on procedures alone
- focus on improving the ideas of the entire classroom community instead of solely on the individual learner
- emphasize collaborative learning experiences within a classroom environment, where students openly and publicly negotiate their ideas with each other
- strive to help students "regard themselves and their work as part of the civilization-wide effort to advance knowledge frontiers" (Scardamalia & Bereiter, 2009, n.p.)

Table 1 summarizes the 12 Principles of Knowledge Building that grew out of a shared history of research at the Institute for Knowledge Innovation and Technology (IKIT), in partnership with The Laboratory School at the University of Toronto. These 12 principles represent the foundational building blocks of Environmental Inquiry and are embedded throughout the classroom examples provided in this resource. Importantly, teachers can use these principles as a guide, not a set of procedures, for understanding and implementing Environmental Inquiry. To learn more about the origin and research surrounding these principles, visit: www.ikit.org.

Table 1: The 12 Principles of Knowledge Building

Real Ideas, Authentic Problems	Knowledge problems arise from efforts to understand the world. Ideas produced or appropriated are considered as real as concrete objects that are touched and felt. Problems are ones that learners really care about – they are usually very different from problems presented in textbooks and puzzles.
Improvable Ideas	All ideas are treated as improvable. Participants work continuously to improve the quality, coherence, and utility of ideas. For such work to prosper, the learning culture must assure psychological safety, so that individuals feel safe in taking risks, revealing ignorance, voicing half-baked notions, and giving and receiving criticism.
Idea Diversity	Idea diversity is essential to knowledge advancement, just as biodiversity is essential to the success of an ecosystem. To fully understand an idea is to understand the ideas that surround it, including those that stand in contrast to it. An environment of diverse ideas and perspectives enables new and more refined ideas to evolve.
Epistemic Agency	Participants set forth their ideas and negotiate how they "fit" or compare with the ideas of others. They seize upon contrasting or different ideas to help them deepen their understanding instead of depending on others to chart that course for them. They take responsibility for issues (such as goal-setting, motivation, evaluation, and long-range planning) that are normally left to teachers or managers to resolve.
Community Knowledge, Collective	Contributions to the organization's shared, top-level goals 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 community knowledge.
Democratizing Knowledge	All participants are considered legitimate contributors to the shared goals of the community. All take pride in the knowledge advances achieved by the group. The group's diversity and divisions do not translate into hierarchies of "knowledge haves and have-nots" or "innovators and non-innovators".
Symmetric Knowledge Advance	Expertise and knowledge are exchanged within and between communities. Symmetrical knowledge advancement results from this "give-and-take" of knowledge.
Pervasive Knowledge Building	Knowledge building is a pervasive, continuous process of learning, both in and out of school, rather than an activity relegated to particular occasions or subject areas.
Constructive Uses of Authoritative Sources	Up-to-date knowledge of a discipline requires continuous learning and re-assessment. This can be achieved through the respectful use of, and critical stance toward, authoritative sources of knowledge.
Knowledge Building Discourse	The discourse of Knowledge Building Communities results in the sharing, refinement and transformation of knowledge. The explicit goal of these discursive practices is to advance the learning community's knowledge.
Embedded, Concurrent and Transformative Assessment	Learning communities embed assessment in their day-to-day workings in order to identify problems in knowledge advancement. Through rigorous, finely-tuned assessment, they are able to achieve transformative outcomes that exceed the expectations of external assessors.
Rise Above	Creative knowledge building entails working toward more inclusive principles and higher-level formulations of problems. It means learning to work with diversity, complexity, and messiness, and from that, achieve new syntheses. By moving to higher planes of understanding, knowledge builders transcend trivialities and oversimplifications and reach beyond current best practices.

* Source: Scardamalia (2002)

What is Knowledge Building (KB) Discourse?

Another key component of the inquiry process is Knowledge Building Discourse, a communal activity in which learners come together to pose questions, posit theories, and to revisit, negotiate, and refine their ideas. The collective goal is 'idea improvement'. Knowledge Building Discourse "serves to identify shared problems and gaps in understanding and to advance the understanding beyond the level of the most knowledgeable individual" (Scardamalia, 2002, p. 12).

Knowledge Building Discourse builds upon a long tradition of classroom discussion, with a focus on deepening students' understanding through increased exposure to the diverse perspectives and ideas of the class. It is a class discussion time that is specifically reserved for working out students' emergent questions and ideas, rather than a teacher-directed forum for eliciting 'correct' answers to curriculum-based questions. What typically emerge from Knowledge Building Discourse are students' new/unresolved questions or theories, which in turn serve as entry points for further investigation.

Knowledge-Building Discourse differs from traditional classroom discussion in several important ways as outlined in Table 2.

Table 2: The Unique Role of Knowledge Building Discourse in Inquiry-based Learning

Discourse, rather than content delivery, shapes the direction and manner of learning.
The teacher does not necessarily know in advance all of the questions and answers that may emerge from student discourse.
The teacher nurtures student engagement by asking open-ended questions such as: "Did anyone notice/read/find out something that might help us understand our question?"
Students attempt to reconcile their own theories and ideas in light of new sources of information. Teachers support them in this process by asking questions such as: "How does that information support your theory? Have you changed or added to your theory?"
The teacher models and facilitates multi-directional dialogue to help students internalize and practise it themselves. "Does anyone have something to build onto Joseph's idea? Joseph, please pass-on to another student."

"The goal of Knowledge Building is not simply to create life long learners, but rather, life long contributors."
– Carl Bereiter, Co-founder of the Institute of Knowledge Innovation and Technology, University of Toronto

Knowledge Building Discourse and final project/oral presentations

For decades, oral presentations have been a mainstay of knowledge sharing in traditional learning environments. The teacher asks students to prepare a final project on a subject and present it to the class in the form of an oral presentation. Students listen passively to the presentation, and then the class moves on to the next unit or next presentation. While some learning does occur, a host of enriched learning opportunities are lost including:

- building on the knowledge that the student has shared with the class
- making connections that might lead to idea improvement by the whole class
- contributing to students' understanding about the content

Furthermore, the critical-thinking processes that students use to develop the final product are not obvious and, therefore, may not be acknowledged and/or valued.

Yet students do experience a sense of accomplishment when they, as 'experts', share their knowledge with the class. For precisely this reason, teachers should provide opportunities for students to participate in frequent Knowledge Building Discourse. This practice moves 'knowledge telling' presentations beyond isolated, one-time events to learning opportunities that can benefit the entire Knowledge Building community.

What is a Knowledge Building (KB) Circle?

Photo 1: A Knowledge Building Circle

The term Knowledge Building Circle refers to the seating configuration of students as they engage in Knowledge Building Discourse. The circle is an intentional physical configuration that is conducive to successful Knowledge Building for several reasons:

- **Circles promote attentive listening and communication.** The physical shape facilitates face-to-face dialogue amongst students. Eye contact and 'attentive' body language – physical signs of respect and active listening – are more visibly apparent.

- **Circles eliminate hierarchy.** All students enjoy an equal place in a circle. No one student takes precedence over another. The teacher takes his or her place within the circle as a co-learner. As members of this egalitarian knowledge building community, students both learn from, and contribute to, each other's understanding. They take turns speaking and wait patiently for their turn. In Early Years classrooms, or in classes at any grade level that are new to Knowledge Building Discourse, the teacher may direct the conversation by selecting which student with their hand up will speak next. The goal is for the students to eventually raise their hands and wait for the student who has just spoken (not the teacher) to choose who will speak next.

- **Circles foster respect for all life.** Learning how to communicate respectfully with others is an important aspect of children's social development, and integral to developing their sense of respect for all life. If we cannot help our students respect each other, how then can we expect to help them to respect the environment?

Initially, especially in a class of 25-30 students who are new to KB Circles, the teacher may need to work with students to establish agreed upon expectations for ensuring behavioural and mutual respect during KB Circles (See Box 14 on page 126).

The teachers in Part 2 of this resource have found that this is a worthwhile investment of the class' time. Overall, teachers have found that when students become accustomed to the process, and are engaged in dialogue about a topic that is important to them, classroom management issues tend to diminish.

Linking to Aboriginal Perspectives on Learning

The Knowledge Building Circle is not a novel idea. It aligns with the wisdom of a time-honoured tradition of Indigenous cultures, the Talking Circle, in which individuals take turns sharing ideas.

A symbol of connectedness and harmony, the circle is also found in the Medicine Wheel used by the First Nations of the Plains. The Medicine Wheel is divided into four quadrants to convey the passage of the four seasons; the interactions of emotional, physical, intellectual, and spiritual aspects of human development; and the interconnectedness of all life (Ermine, as cited in Battiste & Barman, 1995).

Furthermore, Indigenous philosophies of education are the oldest continuing expressions of Environmental Education. Importantly, they can help to enrich the thinking behind Inquiry and Knowledge Building. Gregory Cajete, Indigenous educator, artist and Environmental Education consultant, advocates "a way of looking at and understanding a primal process of education that is grounded in the basics of human nature". This shift in orientation enables individuals "to reach completeness by learning how to trust their natural instincts, to listen, to look, to create, to reflect and see things deeply, to understand and apply their intuitive intelligence" (2004, p. 23).

Inquiry-based Learning is likewise grounded in a primal process inspired by natural instincts. As described earlier in this chapter, instinctive sensory explorations represent humans' earliest attempts to make sense of the world. Indeed, there are several parallels between Indigenous perspectives on education and those of Inquiry-based Knowledge Building. For this reason, the work Dr. Cajete is often cited in this resource.

2. Putting It Into Practice

What Does an Inquiry-based Classroom Look Like?

In an inquiry-based classroom, most decisions that teachers make, from choosing wall displays and configuring students' desks to reserving a gathering place for class discussions, is based on their desire to put the principles of Inquiry and Knowledge Building into practice. Teachers, therefore, continuously strive to balance what is practical with the following considerations:

- *Is this conducive to creating an environment where students' ideas and thinking will be at the centre?*
- *What message will this send to the students about my own values about learning?*

Classroom walls

- **At the start of the school year**: The walls of an inquiry-based classroom are quite bare, aside from perhaps a welcoming visual display of children's names. Few, if any, pre-purchased teaching visuals are on display. The reason? Teachers want their students to understand that the classroom belongs to the whole community of learners, not just the teacher. The walls serve as blank canvases to be filled with students' questions, ideas, and multiple expressions of understanding.

- **Throughout the year**: Representations of student learning – as expressed in art, writing, sculpting, and building – are displayed on walls throughout the classroom. A prominent section of one wall is devoted to the questions, ideas, and theories that have emerged from Knowledge Building Circles. The purpose of this display is not to showcase the 'best' work, but to archive all ideas, including the less accurate or developed. This approach also makes the growth of students' understanding over time explicit.

Such egalitarianism serves to reinforce values such as respect for diverse ideas, thereby creating a culture of psychological safety that is integral to learning. Students are more likely to "feel safe taking risks, asking questions, revealing ignorance, voicing half-baked notions, and giving and receiving criticism" (Scardamalia, 2002, p. 9). They come to understand the value of questioning, thinking critically and contributing ideas. They learn that producing the correct answer or end product is not the full measure of learning success. By extension, they come to appreciate their own value as learners.

Teachers and students can use the displayed questions and theories as reference points for:

- deciding how to improve existing ideas
- initiating Knowledge Building Discourse
- seeing how their previous ideas have improved

Ideally, evidence of student questions and theories remain on display for as long as possible – even when the class has moved on to another topic. This leaves open the possibility that students will build connections with new content, while reinforcing the notion that individual learning about a particular subject can continue even if the focus has shifted to another area of the curriculum.

> *"The theories children build, whether they are right or wrong, are not capricious. They are often logical and rational, and firmly based in evidence and experience."*
> – National Science Foundation, *Inquiry: Thoughts, Views, and Strategies for the K-5 Classroom* (2001)

Configuration of desks

In an inquiry-based classroom, desks are arranged in groups, with students facing each other. This configuration encourages students to exchange ideas, learn from one another and solve problems of understanding together. In contrast, desks arranged in rows and facing the teacher's desk at the front of the room create a narrow path of communication that hinders Knowledge Building and signals to students that learning occurs solely through the teacher.

Reserving a gathering place for Knowledge Building Discourse

Teachers reserve a space, ideally a carpeted area in the classroom, for students to gather regularly for Knowledge Building Circles. Students understand that this space is a designated area where they are encouraged to exchange, negotiate, and build on each other's ideas. Students sit together in a circle on the carpet along with the teacher.

How Do Teachers Start the Inquiry Process?

There is no single way to begin an inquiry. Students have diverse personalities, learning styles, talents, and interests across grade levels. Therefore, teachers use a variety of strategies to stimulate their students' curiosity and initiate the inquiry process, as summarized in Table 3. A teacher may choose to use one strategy, or a combination thereof, before asking students to share their questions about a topic.

Table 3: Strategies for Sparking Students' Curiosity

Connect the topic personally to students' lives
Take your class outside
Engage students in interactive read-alouds
Provide opportunities for students to witness observable natural phenomena
Elicit prior knowledge first
Pay special attention to questions, suggestions or observations that arise spontaneously
Provide introductory hands-on experiences
Revisit related questions or topics of interest from previous inquiries

Connect the topic personally to students' lives

Students are much more interested in exploring a topic when they appreciate its relevance to their own lived experience. To help them make this connection, teachers in an inquiry-based learning environment often ask their students to bring in a physical artefact related to the current topic, and connect it to a personal event in their lives. In doing so, teachers invite the whole child, personal experiences and all, into the learning process.

Personal Connections: Example 1

Grade 2 teacher, Norah L'Espérance, planned to begin the school year by exploring the topic of water with her students. Over the summer, she wrote to each of her students, asking them to bring in a sample of water from a place where they had spent time during the summer.

In September, students brought in water from a variety of places: a relative's home, a public pool, a foreign country, a summer camp, a kitchen faucet at home (see Photo 2). Each child demonstrated their personal relationship to water by telling the story of their summer through this natural artefact: where they had been, what they had done, and with whom they had spent their time. Through this experience, the Grade 2 students recognized that each individual had a personal connection to water, but also to each other. Each child then poured a portion of his or her water into a large communal jug to symbolize the interconnected community that had formed through this dialogue about water.

Photo 2: Water Samples from the Grade 2 Class

> *"It is the affective elements – the subjective experience and observations, the communal relationships, the artistic and mythical dimensions, the ritual and ceremony, the sacred ecology, the psychological and spiritual orientations that have characterized and formed Indigenous education since time immemorial."*
> – Gregory Cajete, *Look to the Mountain: An Ecology of Indigenous Education* (1994).

Personal Connections: Example 2

Grade 4 teacher, Krista Spence, planned to begin the school year with an inquiry into Rocks and Minerals. During the summer, she wrote to her students, asking them to bring in a rock from a path or garden near their home, or wherever they may have spent time. She also asked them to bring in a map of where they had found it. She enclosed each letter with a photo of herself surrounded by breathtaking, unusual rock formations (see Photo 3). Come September, each student told the story of their rock to the class. The stories were remarkably varied. Each student also explained why he or she had chosen that particular rock and talked about what kind of rock it could be.

Photo 3: Grade 4 Teacher Modelling Curiosity for Rocks

Take your class outside!

Students need to experience the natural environment in order to fully appreciate its wonders. They need meaningful opportunities to explore the environment in its various forms. This need not involve an excursion to a distant forest or river. A short walk around the school community or to the local park, during which students are encouraged to explore their surroundings using all of their senses, can awaken curiosity and spark a few questions (See pages 39-42 for examples).

Elicit prior knowledge first

Children sometimes find it easier to posit questions about a new topic after the teacher has given them the opportunity to describe what they already know about it. For this reason, teachers sometimes begin an inquiry by asking students to draw or write about what they know about the topic. Once each child has documented his or her own ideas, the teacher brings the entire class together in a Knowledge Building Circle. It is then that the teacher asks, "What are you interested in learning more about?" (See page 63-64 for examples).

Engage students in interactive read-alouds

Reading a storybook aloud to the class is an effective way to activate students' knowledge and questions about a topic, and an alternative to simply delivering the facts. In the primary grades, realistic fiction and vivid illustrations work well at the onset of an inquiry for both visual and auditory learners, as well as English language learners (See page 135 for example).

Provide opportunities for students to witness observable natural phenomena

Students become immediately engrossed in witnessing natural processes. Whether it is watching pumpkins rot, waiting for a chick to hatch, a butterfly to emerge from its chrysalis or salmon eggs to turn into fry, these mysteries of life always generate a myriad of questions (See pages 80, 125-126 for examples).

Pay special attention to questions that arise spontaneously

Students are constantly asking questions, some of which are spontaneous and unexpected. Spontaneous questions arise in various situations, including Knowledge Building Circles or small-group discussions that the teacher has overheard.

Often, student questions that arise without teacher prompting represent a very genuine kind of curiosity. Even if they seem vague or initially difficult to fathom, spontaneous questions provide teachers with valuable clues about the students' thinking processes and interests. This is especially true in the very early years, when four-year-olds, for example, may still be learning what a question is, and how to ask it. The teacher records these spontaneous questions, reserving them for later use. The practice of revisiting spontaneous questions

by plucking them from a list and offering them as prompts, is an effective way to begin an inquiry at any grade level (See pages 88, 104, and 112 for examples).

Provide introductory hands-on experiences

Engaging children in an introductory hands-on experience such as planting or digging through soil to deconstruct its composition has been shown to inspire student questioning (See pages 93 and 128 for examples).

Revisit related questions or topics of interest from previous inquiries

Sometimes, students pose questions in a previous topic of study that relate closely to the current Inquiry. Revisiting questions or areas of interest that students have revealed in the past can serve as helpful entry points for further questioning in a related topic (See pages 88 and 147 for examples).

What is the Role of the Teacher?

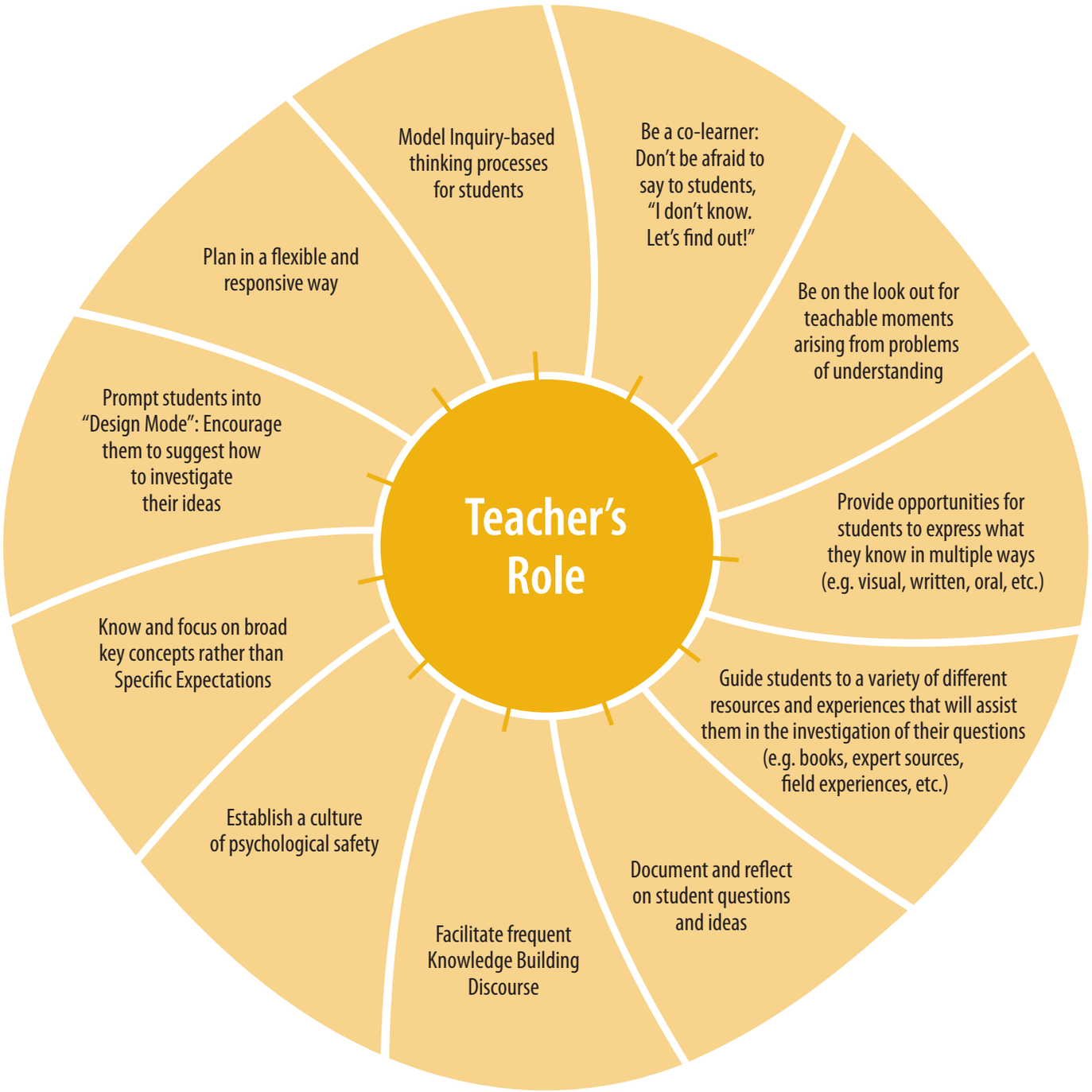
The concept map shown in Figure 3 outlines the teacher's key functions within an inquiry-based learning environment. A teacher may exercise few, some, or all of the roles described in Figure 3, depending on his or her degree of experience with Inquiry. For example, many teachers already "provide opportunities for students to express what they know in multiple ways", but may not have experience "documenting and reflecting on student questions" as a means of informing subsequent planning. As teachers become more comfortable moving from teacher-directed to student-centred teaching methods, they gradually build these roles into their instructional repertoire.

In more traditional classrooms, the teacher is the expert and arbiter of knowledge, who transmits information to students through a prescribed, but well-organized series of lessons that cover each curriculum expectation. In comparison, an overall examination of Figure 3 suggests that the general role of a teacher in an inquiry-based learning environment is that of facilitator.

While the role of "teacher as facilitator" is certainly a fundamental component of inquiry-based instruction, it is also important for teachers not to construe Inquiry as an approach that prohibits any and all forms of teacher-directed instruction. This purist, "all or nothing" stance would likely deter many teachers from exploring this rich and engaging method of teaching and learning. Depending on the topic, learner, or question, certain circumstances may call for more teacher-direction than others. For example, the teacher role in Figure 3 that reads, "Be on the look out for teachable moments arising from problems of understanding" alludes to learning situations that may require some form of teacher-direction (See page 20 for further details).

What is important, however, is that teacher-directed instruction occur in moderation, for the purpose of gently scaffolding students toward their learning goals, and in turn, to help students feel successful as learners. Using professional judgement to decide when it is appropriate to provide more or less teacher-direction is, after all, part of the "facilitation" process.

Figure 3: Concept Map of the Teacher's Key Roles in an Inquiry-based Learning Environment



Some of these roles are self-explanatory. Others, such as modelling inquiry-based thinking processes and flexible planning, may be less obvious to teachers who are new to Inquiry-based Learning.

Modelling Inquiry-based thinking processes for students

Teachers model inquiry-based thinking processes by posing the kinds of open-ended questions they want their students to eventually internalize and ask of themselves as they learn to become independent problem-solvers. As Scardamalia notes, "By serving as a model of expert learning, the teacher helps students gain insight into the executive processes by which learners take charge of their understanding" (2000, p. 6). Examples of these kinds of questions include:

- "What do you notice?"
- "What do you think might happen if…?"
- "What does this make you wonder about?"
- "I wonder why your plant grew shorter than Samira's?"
- "What can we do to find out?"
- "Why do you think that happened?"

Planning in a flexible, dynamic and responsive way

Adherence to a pre-determined set of lessons in a unit plan is counterintuitive to the goals of Inquiry-based Learning and Knowledge Building. Learners need opportunities to explore and satisfy their innate curiosity, to pursue questions that might lead them down an exciting yet unexpected path. In an inquiry-based environment, teachers allow students' questions, ideas, and misconceptions to chart the course of their learning, and ultimately inform the direction of planning. But how do teachers do this?

Table 4 provides examples of lead-in actions that teachers can use, and it illustrates the dynamic interplay between students' questions and teachers' responsive planning.

Table 4: Planning for Inquiry-based Learning

Key Actions	Example
Choose a key concept related to curriculum	Soil Ecosystems
Brainstorm all possible directions it can go, how it might connect to big ideas in the curriculum, and to other strands or areas of the curriculum.	Rocks and minerals; planting, worms, food, composting, agriculture, insects, habitats
Brainstorm initial supporting resources that may be useful.	Magnifying glasses; information and story books; field trips; guest speakers; soil samples; multi-media resources
Decide what the first lead-in experience(s) will be.	Take students outside to collect soil.
Have the students form a Knowledge Building Circle to talk about the first lead-in experience, in order to assess what students know and want to know.	• "What did you notice? What do you know about soil? What do you wonder?" • Document questions and theories that arise in discussion.
Reflect on the students' shared questions and ideas and how they could be used to inform subsequent planning.	*"Hmm. Many of the children posed questions about worms and how they help soil. We might benefit from seeing some worms in a terrarium or even a vermicomposter."*
Decide if students will be exploring questions individually, in small groups, or as a whole group.	• Younger students from K to Grade 2 usually investigate questions as a whole group because their reading skills are still developing (This may vary depending on the group). • Students in older grades are more able to branch out into groups to investigate different questions independently.

Look for teachable moments and problems of understanding

Students often begin inquiries without recognizing that they may need to learn other pieces of information in order to fully comprehend their original questions. As students investigate, gathering information from books and audio-visual media or through experimentation, they may come to an impasse in their understanding. They may discover that very few age-appropriate reading materials are available to help answer their questions. Teachers need to be cognisant of such moments and be prepared to support their students in one or more of the following ways:

- Guide and encourage students to re-think and reformulate their question so that it is more accessible (See page 149 for example).
- Encourage students to bring their problem of understanding to a Knowledge Building Circle to see if other students have ideas that could clarify the problem.
- Direct students to helpful resources.
- If a number of students in the class have reached a similar roadblock, carry out a mini-lesson to clarify the problem of understanding.

"As the teacher engaged in this kind of learning process, it's about knowing that the kids will be heading down a particular road, and that they may need to know certain things in order to reach their destination. If they need to know x in order to learn y and z, then I need to be aware of that and somehow find a way to show them x."
– Ben Peebles, Grade 5/6 teacher

Focus on the overall curriculum expectations instead of specific outcomes

Vice Principal, Richard Messina (2001), notes, "In coverage-oriented instruction, topics are merely checked off and students move on whether there is understanding or not" (p. 21). However, when teachers focus on the larger overarching ideas rather than on specific facts alone, they discover that students' questions are far more likely to connect with, and often exceed, curriculum expectations. This was the case for teachers in the Toronto and York Catholic District School Boards who piloted Environmental Inquiry. At the end of the school year, they reviewed the content that had been covered and realized that their classes had addressed all of the required curriculum expectations and more!

Establish a culture of psychological safety

Students need to feel a sense of security within their learning community in order to take intellectual risks, ask honest questions, and posit inchoate theories. They need assurance that they will not be judged or ridiculed and that they can make contributions without needing to be 'correct' or 'sound smart'. To create a culture of psychological safety, teachers model patience and neutrality by using a variety of techniques:

- **Encourage children to wait a few seconds before giving an answer to allow time for thinking.** Tell the students you are going to ask a question, but you would like them all to close their eyes and think about it for a few moments before answering (Ogu & Schmidt, 2009, p. 15).
- **Repeat or paraphrase what the children say without praising or criticizing.** This practice encourages children to think for themselves instead of seeking teacher validation. "Joe thinks that sand comes from rocks and Andrea says it is dirt from the ocean. What do you think? Where does sand come from?" (Ogu & Schmidt, 2009, p. 15).
- **Be a co-learner. Don't be afraid to say, "I don't know. Let's find out!"** If the teacher can admit that he or she does not know the solution to a problem, then students will also feel more willing to admit their own uncertainties. On occasion, the teacher may even feign ignorance in order to encourage students to problem-solve: "That's a great question! How can we try to figure it out? Where can we look?"
- **Post students' questions and theories on display** (See page 14 for a full description).

When and How Often Should Students Engage in Knowledge Building (KB) Discourse?

Ideally, Knowledge Building Discourse should be a regular and frequent follow-up activity to students' knowledge work (both within and outside the classroom). Regular KB Discourse encourages students to become critically mindful of their investigations, to guard against making cursory observations or reading information in a perfunctory manner. As students become accustomed to the process of reporting back to the group, they develop a sense of responsibility for their learning and a desire to make meaningful contributions to the collective. In the process, critical thinking and self-reflection become habitual modes of inquiry.

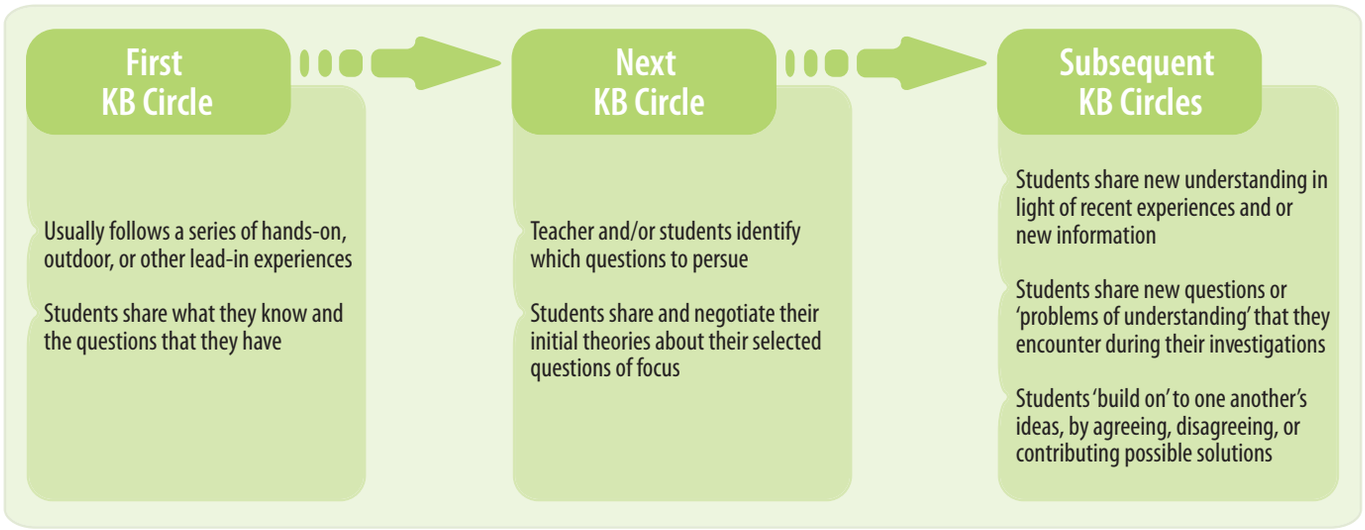
Ideally, regular Knowledge Building Discourse can be organized in a few ways:

1. Some teachers choose the largest block of uninterrupted time available in the day, and set it aside for students to work on their inquiry investigations (e.g., recording experimental observations, reading research, outdoor exploration, multi-media research, etc.). The teacher may then reserve the final 15 – 30 minutes of the time block for a Knowledge Building Circle. Doing this enables students to come together as a whole group to critically reflect on their work, report on new understandings, and share questions or modified theories.

2. Teachers who do not a have a large enough time-block in the course of one day may choose two separate blocks during the week for students to work on their inquiry investigations, as shown in Figure 4. Ideally, the first time-block of the week is reserved for student research and investigation. The second is set aside for follow-up in a Knowledge Building Circle.

3. For young children in the early years, KB Discourse may occur on a more informal basis. For example, teachers may jump on a spontaneous opportunity to gather the class in Knowledge Building Circle.

Figure 4: Progressive Unfolding of Knowledge Building Discourse



How Do You Assess Students in an Inquiry-based Learning Environment?

In an inquiry-based classroom, the teacher relies upon his or her extensive documentation of each student's questions and emerging ideas as the foundation for assessment, evaluation, and reporting. This approach acknowledges that "virtually all classroom activities, whether formal or informal, provide teachers with information that can be used to monitor learning progress" (Fostaty Young & Wilson, 2000, p. 13). On a daily and hourly basis, teachers make assessment decisions that have a profound effect on individual students and groups of students (Ontario Ministry of Education, 2010a). Assessment is an ongoing process embedded in everyday classroom life throughout an entire inquiry, not just at the end. Examples of embedded assessment are interwoven throughout the classroom stories in the latter half of this resource.

Inquiry-based assessment, evaluation, and reporting is as student-centred as the inquiry-based learning process itself, and can be characterized as follows:

- focuses on the developmental growth of each student over time, instead of comparing where he or she stands relative to other students
- strives to make students' thinking processes explicit and visible
- strives to embed assessment into everyday classroom life throughout the entire inquiry unit, beyond diagnostic, formative, and summative boundaries
- designed to highlight the qualitative development of a student's learning skills and higher-order thinking skills, more so than a student's accumulation of information in strictly quantitative terms
- aims to be as helpful and transparent for students and families as it is for the teacher
- based on ongoing, and varied sources of student expression; teachers encourage students to demonstrate their emerging understanding in a variety of ways in order to respect and support the diverse learning modalities, interests, needs, and experiences of all learners (Ontario Ministry of Education 2010a).
- geared toward developing "students' self-assessment skills to enable them to assess their own learning, set specific goals, and plan next steps …" (Ontario Ministry of Education, 2010a).

Multiple sources of assessment

In an inquiry-based classroom, the teacher assesses student progress on a continuous basis throughout the school year, collecting and using a wide range of information to provide an informed and comprehensive picture of the student's learning. Enabling students to express their understanding in differentiated ways is crucial for many reasons, but especially for the following:

- The teachers' ability to differentiate instruction and assessment as a means of helping students understand how they can improve is closely related to the feelings that students have about themselves as learners specifically, and about learning in general (Ontario Ministry of Education, 2010a).
- "Using multiple sources of evidence increases the reliability and validity of the evaluation of student learning" (Ontario Ministry of Education, 2010a).

Some examples of varied and authentic assessment sources include, but are not limited to:

- student questions;
- Inquiry Lab Books;
- portfolios;
- visual art; and
- anecdotal observations.

The benefits and strategies for using each of these assessments are described in pages 23-29.

Students' questions

By documenting and revisiting students' questions, teachers not only collect data that will inform the direction an inquiry may take and what resources to procure; they also gain insight into the learner's place along a developmental growth continuum. A student's questions can provide teachers with information about a student's understanding of the content area at hand, as well as his or her level of critical thinking (See Table 5). This is one important reason why teachers seeking to foster an inquiry-based learning environment make a concerted effort to record students' questions that arise during Knowledge Building Circles.

> *"The questions that students have provide insight into where they are in their understanding. Some kids will ask really deep and detailed questions and you think, "Okay, he knows a lot about that." Other students may be at a really basic question-asking level, which can be an indicator that they don't have deep background knowledge about the topic."*
> – Julia Cain, Grade 5/ 6 teacher

Table 5: Assessing the Content and Quality of Students' Questions

Assessment Considerations Arising from…	
…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?

Implications for English language learners

English language learners possess just as much curiosity as students for whom English is a first language. In fact, students who are new to Canada may have even more questions about their new surroundings than their English-speaking peers. By eliciting questions from English language learners, teachers can foster an inclusive classroom environment while also collecting valuable assessment information about their students' prior knowledge and interests.

"Inviting students to [share their questions] in their first language as well as in English enables them to draw on their strengths, including their existing academic, linguistic, and cultural knowledge. This approach also enriches the class environment by exposing English-speaking students to the advantages of knowing more than one language and of cultural diversity in general" (Ontario Ministry of Education, 2005a, p. 15).

Here are a couple of ways that teachers can encourage question asking among their English language learners while welcoming the use of their first language:

- **Work together with an adult member of the student's family to help with translation**. For instance, after engaging the class in an experiential, hands-on activity, teachers can asks students to state or write their questions in their first language and then ask parents to help translate. This kind of interaction with families will also "foster parent engagement in the students'

educational experiences and achievement" (Ontario Ministry of Education, 2007a, p. 28).

- **"Give English language learners opportunities to work with same-language partners"** (Ontario Ministry of Education, 2005a, p. 15). For example, an English language learner can engage in a "think, pair, share" with a same-language peer in order to exchange questions and ideas about a topic in their first language. This strategy also serves to empower students with the notion that they can be learning resources for each other.

"[There is] ample evidence that, even at a pre-school stage, [English language learners] are anything but blank slates. They bring with them a dizzying array of life experiences which, along with their differing cultural and linguistic backgrounds, make them anything but a homogenous group"
– Handscombe, 1994, as quoted in Ontario Ministry of Education, 2005a.

Inquiry Lab Books and portfolios

Inquiry Lab Books are often used as a central repository for learners to record the following information related to their inquiry:

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

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 (For examples, see Carol's Story, page 69; Robin's Story, page 86; Ben's Story, page 93; and Cathy's Story, page 152).

"If you are paying any attention whatsoever during this inquiry process you will have a really fine-grained understanding of what the child understands; and a much more fine-grained understanding than if you were only to rely on a series of tests. Even a really well-written test only reveals what a student happens to recall or output on a particular day. But with Inquiry, they have multiple ways of demonstrating their understanding over time. So you see their developing understanding, as opposed to a snapshot in one moment."
– Ben Peebles, Grade 5 / 6 teacher

Drawings and other forms of visual art

Student drawings, or any visual mode of expression, provide teachers with valuable assessment opportunities, especially during, but not limited to, the early or primary years. Providing opportunities for students to show what they know in a visual form also respects the needs of learners who find it challenging to express their understanding through words alone. A student who has yet to come into his or her writing skills (i.e., Kindergarten or Early Primary), or who experiences particular difficulty with written expression at any grade level, may be able to provide more information about his or her knowledge in a drawing. The fact that a student may not possess particularly strong writing skills does not mean that he or she is devoid of ideas or knowledge. An important role of the teacher is to find alternative or supplementary access points to those ideas (See page 25 for example). This strategy is consistent with the Ontario Ministry of Education's policy document, Growing Success (2010a), which states that assessment practices should "support all students, including those with special education needs, those who are learning the language of instruction (English or French), and those who are First Nation, Métis, or Inuit" (p. 6).

"A vision of schools in which the purpose is deep understanding of ideas and concepts requires a dramatic change in the assumptions underlying education and it requires a different view of schools, schooling, teachers, teaching, and, particularly, assessment."
– Lorna M. Earl, in Teaching for Deep Understanding (2004)

In Julie Comay's JK class, the students were studying the development of a chicken, from egg to hatchling. Notice the knowledge and vocabulary that was revealed through this JK student's drawing of a chicken's development from "a little dot" to "growed up." (See Photo 4).

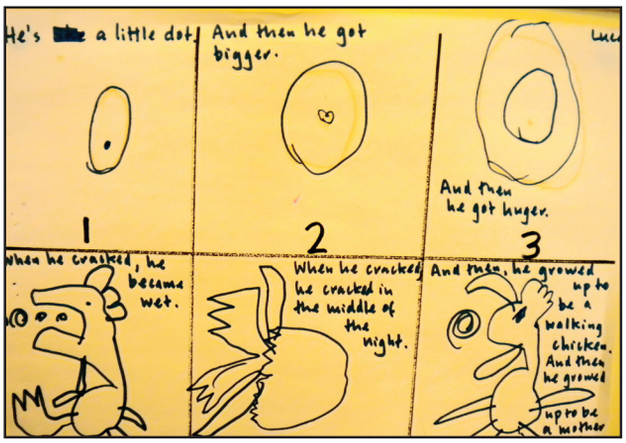


Photo 4: A JK Student's Drawing and Scribed Reflection

Students' drawings also allow the teacher to consider a student's attention to detail, especially when his or her drawing is intended to represent an observation. If a student is having difficulty reflecting, positing new theories, or asking new questions after making an observation, it may be that he or she has not thoroughly looked at all aspects of the experiment. A drawing illuminates the student's perspective. By what is included or excluded, a teacher may identify which elements of an experiment that a student finds most relevant, or that he or she may be overlooking (See Photo 5 and page 96 for another example). Analyzing and interpreting evidence of student learning in this manner is an essential step in the assessment process (Ontario Ministry of Education, 2010a).

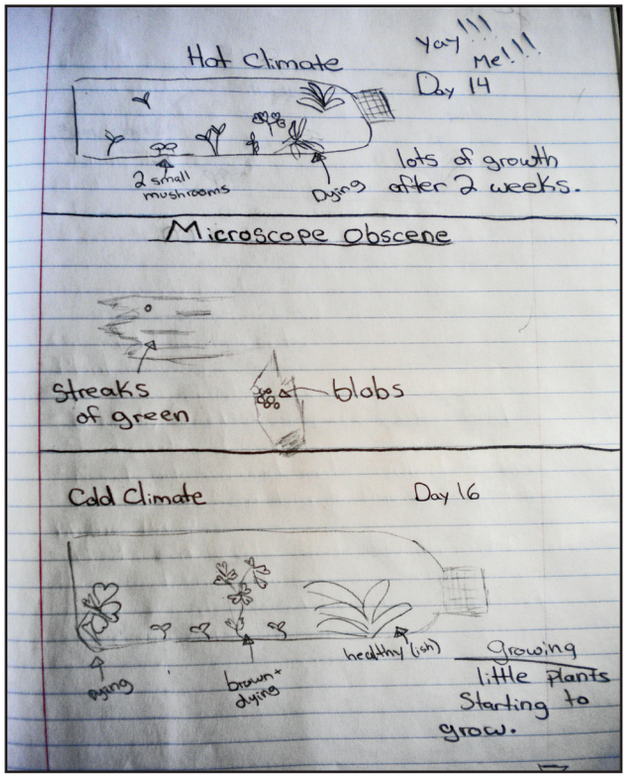


Photo 5: A Grade 5 Student's Observation

Documenting anecdotal observations

Student-Student Small Group Interactions

In inquiry-based classrooms, teachers also consider the interactions that occur between students during small-group work, as these can also reveal students' developing understanding. In junior grades, especially, when students have enough independence to investigate their questions in pairs or small groups, it is helpful to casually walk around the class to observe and listen to student interactions, while informally recording notable student remarks, questions, or observations. In this way, the teacher can assess the extent to which a student has internalized newly-acquired concepts. The manner in which a student naturally draws upon newly acquired concepts within the group makes this evident, and is often the truest sign of a student's understanding (or misunderstanding).

Mini-Conferences

Holding mini-conferences with research groups that are investigating a question or problem of understanding is also a valuable assessment

opportunity. Talking with each group for just 10 minutes about what they are grappling with can provide a detailed sense of each student's level of understanding, as well as the kind of learning skills and work habits that are necessary for student success, and emphasized on all provincial report cards (See Table 6). However, it is important that these conferences remain informal, so that students continue to feel emotionally secure rather than judged.

> *"Set up play situations that have some focus to them, where you as the teacher can just observe, listen, and throw in really casual questions in really casual ways so it's not always perceived as "I'm assessing you."*
> – Julie Comay, JK teacher

Table 6: Learning Skills and Work Habits in Grades 1 – 12*

Learning Skills and Work Habits	Sample Behaviours
Responsibility	The Student: • fulfils 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	The Student: • 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	The Student: • 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	The Student: • 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; • shares information, resources, and expertise and promotes critical thinking to solve problems and make decisions.
Initiative	The Student: • looks for and acts on new ideas and opportunities for learning; • demonstrate 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	The Student: • 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.

*Source: Ontario Ministry of Education (2010a)

Experiential Learning Activities

A non-threatening way to gain insight about students' understanding is to ask them probing questions while they are in the midst of focused experiential activities.

For instance, during an inquiry about Structures, Rhiannon, Grade 2/3 teacher at The Grove Community School, gave her students an opportunity to build their own structures using a variety of materials including wood blocks, unifix cubes, legos, and base-ten blocks. After allowing 10 minutes to explore the materials and begin building, she casually approached each child and asked gentle but probing questions about their structures. These questions were informative, providing new insights about the students' initial understandings, as summarized in Table 7.

Table 7: Example of a Teacher's Assessment Notes for a Grade 2/3 Inquiry about Structures

Teacher Question	Student Response	Indication of Initial Understanding
"Why do you think this tower won't stand?"	"The skinny tower won't stand because is doesn't have a big base."	• Importance of form to a structure's stability
"Why do you think the tower fell over?"	"My tower fell over when I put this block on top because it is heavier than the ones underneath it."	• Importance of form to a structure's stability and strength
"Do you think this tower will stand?"	"This tower will not fall over because the pieces [unifix cubes] stick together. If they didn't stick together, we could probably just breathe on it and it could fall over."	• Importance of the type of materials to the strength of a structure • The action of external forces can affect a structure's stability

In these types of situations, the simple act of jotting down students' comments can provide teachers with worthwhile qualitative information. As an inquiry progresses, teachers can periodically revisit this activity to reflect on how student's structures and responses develop over time. A simple chart, such as the one shown in Figure 5, can be used to record and keep track of students' ideas. Similar kinds of record-keeping charts can be used for observing and recording small-group student interactions, and after holding mini-conferences with research groups (described on page 25).

Figure 5: Students' Anecdotal Comments

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

Discourse in Knowledge Building (KB) Circles

Knowledge Building Discourse is a central part of the inquiry process, one that provides teachers with rich opportunities to observe how students use what they know to solve problems of understanding. In particular, KB 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.

When a student contributes an idea to help the group resolve a question or problem of understanding, that student is providing the teacher with an opportunity to assess the manner in which he or she learns, and the depth of his or her understanding. Assessment opportunities during KB Circles include:

- **Expressive language and communication:** Does this student communicate his or her thoughts in a clear and coherent manner such that the rest of class is able to understand and respond?
- **Ability to interact with diverse ideas and perspectives:** Does the student listen to other students' ideas and agree or disagree in a positive way?
- **Contribution to community knowledge:** Does the student make connections and build upon the ideas shared by other students, and in the appropriate context?
- **Ability to use authoritative sources constructively:** Is the student's understanding refined by something he or she has read from a book or heard from an authoritative person who has come in to talk to the class?
- **Understanding of basic concepts:** Has the student revealed a misconception?
- **Flexibility of ideas:** Does the student hold onto his or her own beliefs no matter what?
- **Providing supporting explanation:** Does the student provide evidence for his or her ideas? Where does this evidence come from (e.g., personal experience or anecdotes, observations of naturally occurring phenomena, books, experts, other students)? Does the student draw upon multiple sources of information to improve his or her thinking and understanding?
- **Participation:** Does this student participate in the discourse? Does he or she ask more questions than offer ideas or vice-versa?

There are various methods for recording Knowledge Building Circle questions, ideas, and theories that can help teachers ensure this information is readily available for assessment purposes. For example:

- On chart paper, write down the main question(s) being discussed and record students' ideas underneath for later reflection and analysis.
- Grade 1 teacher Zoe Donoahue often uses a class list to create a tally chart, such as the one shown in Figure 6, for categorizing student comments.

Figure 6: Knowledge Building Discourse Tally Chart

Knowledge Building Discourse				
Date:				
Student	*Theory*	*Supporting Evidence*	*Question*	*Build-on*

Revisiting the questions later in the inquiry

Revisiting the same question or set of questions throughout the course of an inquiry unit is a common and simple strategy to gauge the growth of student learning. Students can express their understanding in writing, orally, artistically, or using all three forms. This strategy allows teachers to ascertain, over a period of time, whether students are incorporating new information or experiences into their growing understanding, and if so, what they are learning and how they are learning it. This strategy also fosters self-assessment opportunities, making the assessment process transparent and less threatening for the student. When students are able to revisit earlier work, their self-confidence increases because they can see concrete evidence of their own growth: Their current understanding is being compared to their early understanding, regardless of whether that starting point was far ahead, far behind, or on par with others in the same class (Fostaty-Young and Wilson, 2000). When teachers ask students to reflect on the progress of their work over time, they invite students into the meta-cognitive process of critically analyzing their own learning (i.e., "Wow. I used to think that, but now I think this!").

Consider Photos 6 and 7: two drawings made by the same child in Carol Stephenson's SK class. The drawing in Photo 6 was created on September 14, when Carol asked the class to show in a drawing everything they knew about bees. This initial drawing revealed this child's preliminary prior-knowledge about bees, which he described orally, as Carol scribed. The drawing in Photo 7, created on October 10, revealed clear growth in this child's understanding. His fine-motor control had not improved significantly, but he clearly had much more knowledge about bees to include and communicate through his drawing.

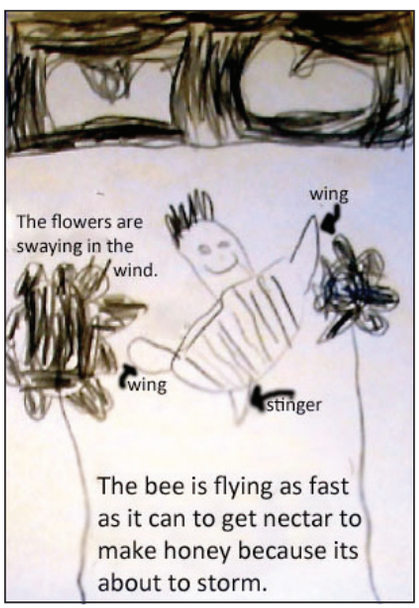


Photo 6: What do you know about bees?*

* Text enhanced to ensure legibility. Original grammar has been maintained.

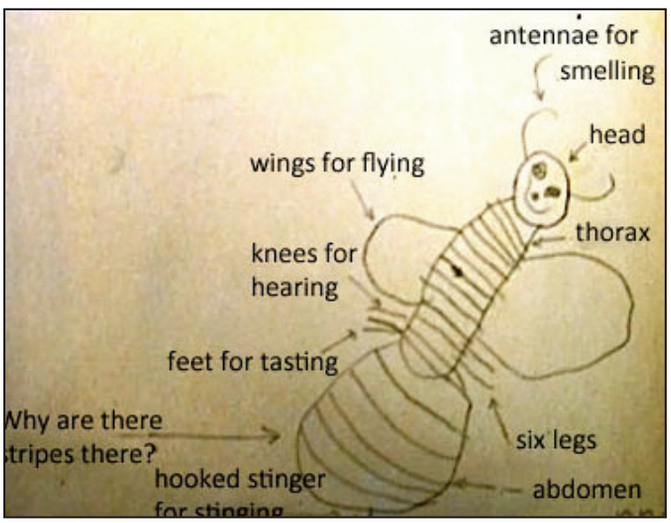


Photo 7: Revisiting the Same Question*

* Text enhanced to ensure legibility. Original grammar has been maintained.

Assessing Learning for Reporting Purposes in Public Schools

The Ministry of Education's policy document, Growing Success: Assessment and Evaluation in Ontario Schools (2010, p. 6), states that "the primary purpose of student assessment and evaluation is to improve student learning". Assessment for the purpose of improving student learning is seen as "assessment for learning" and "assessment as learning". Evaluation for the purpose of public statements such as report cards is referred to as "assessment of learning".

Three Purposes of Assessment
(Adapted from: Earl, 2004 and Growing Success, 2010)

*Assessment **of** Learning*

- reporting to parents and others about student progress to demonstrate whether or not students have met standards (criterion assessment), and/or show how they are placed in relation to others (normative assessment).
- public evaluation of student achievement in the form of symbols such as letter grades or numerical values.

*Assessment **for** Learning*

- the process of gathering and analyzing evidence for use by students and their teacher to determine where students are in their learning, where they need to go, and how best to get there.
- helps teachers differentiate and focus how to approach the learning of individual students

*Assessment **as** Learning*

- to give students information to help them become active and engaged in their own learning and assessment, through teacher modelling
- emphasizes the use of assessment to help develop and support meta-cognition for students.

The Ministry's current policy states that all curriculum expectations must be accounted for in instruction and assessment but, importantly, it emphasizes that "evaluation focuses on student achievement of the overall expectations" (2010, p. 38). The overall expectations are recognized as broad in nature. Teachers are to use their professional judgement "to determine which specific expectations should be used to evaluate achievement of overall expectations, and which ones will be accounted for in instruction and assessment but not necessarily evaluated" (2010, p. 38).

In inquiry-based learning classrooms, teachers need to use their professional judgement to balance these purposes in accordance with their goals and beliefs about how students learn best. For instance, it would be counterintuitive to establish a responsive, student-centred, and developmental learning program that relies primarily on quantitative assessment tools when assigning a grade (e.g., test scores). "Teachers obtain assessment information through a variety of means, which may include formal and informal observations, discussions, learning conversations, questioning, conferences, homework, tasks done in groups, demonstrations, projects, portfolios, developmental continua, performances, peer and self-assessments self-reflections, essays, and tests" (Ontario Ministry of Education, 2010a, p. 28).

Student participation in assessment – assessment *as* learning; assessment *for* learning

Inquiry-based learning environments are clearly weighted in favour of assessment *as* learning and assessment *for* learning since these types of assessments are effective aids for deepening students' understanding, and encouraging student involvement in the learning and assessment process.

One of the 12 Knowledge Building Principles (See page 10) calls for *Embedded, Concurrent, and Transformative Assessment* in the inquiry process, which suggests that students should play an important role in assessing their own learning and that of the entire learning community. The beauty of Inquiry is that from the beginning of the learning process, students are instrumental in establishing learning goals and success criteria for themselves through the very questions that they ask. For example, when a student says, "Do all plants need sun to live and grow?" that student is stating a learning goal.

Teachers in inquiry-based learning environments often engage students in regular Knowledge Building Discourse for the express purpose of finding out what they know or do not know (i.e., assessment). During these kinds of conversations, the students and teacher discuss questions such as: "What do you think are some of the most important things that we have learned about _____ so far? What do you think we still don't understand?" Student contributions to this kind of discourse serve as authentic forms of student self-assessment. With teacher guidance, these can help form the basis for different kinds of learning tasks or assessment tools such as rubrics, surveys, homework assignments, group projects, etc.

For example, in Vessna Romero's Grade 4 math class, the students wanted to find out how much waste their school contributes to the landfill on a given day. They decided to design and carry out a school-wide waste audit in order to learn the answer to this question. Guided by Vessna's skilful questioning (e.g., "How will we organize and keep track of all of the garbage we collect?"), the class decided that they would need to use data management skills to graph their findings. These graphs served as powerful assessment pieces for Vessna, the Grade 4 students, and even the entire school community (See pages 111–116 for full story).

Using "I can" statements as self-assessment tools

An "I can" statement is a simple, open-ended self-assessment tool, where the students state or write what they feel they are able to do in a particular learning domain (Bilash, 2009). Some examples might be:

- "I can state my times tables up to 7 x 7"
- "I can write a haiku."
- "I can take research notes."

"I can" statements can be used daily, weekly, bi-weekly, at the end of an inquiry, or ideally, a combination of these. For instance, before leaving class at the end of an inquiry period, a teacher may ask his or her students to individually complete one or two "I can" statements. Collecting and analyzing these cards enables this teacher to glean information about each of his or her students' knowledge, misconceptions, and sense of self-efficacy in a particular learning area. Moreover, these statements might also reveal a need for the teacher to review a particular concept with his or her class (Bilash, 2009).

Assessment *of* learning

Assessment of learning (e.g., report cards) is a reality in public schools for reasons of public accountability. Consequently, educators often grapple with questions such as: *"How can I translate qualitative evidence of student learning for inherently quantitative reporting purposes?"*

In Ontario, assessment and evaluation occurs on a criterion-referenced basis. That is, teachers assess and evaluate student learning according to success criteria assigned to the following four levels of achievement (Ministry of Education, 2010a):

- Level 1 – "The student demonstrates the specified knowledge and skills with limited effectiveness" (p.18).
- Level 2 – "The student demonstrates the specified knowledge and skills with some effectiveness"(p. 18)
- Level 3 – "The student demonstrates the specified knowledge and skills with considerable effectiveness"(p. 18)
- Level 4 - "The student demonstrates the specified knowledge and skills with a high degree of effectiveness"(p. 18)

On their own, the qualifiers of these achievement levels (e.g., "some effectiveness") do not clearly help students understand why they have been evaluated at a "Level 2", for example. While a teacher may know exactly what constitutes the achievement of this level, students may be left wondering what "some effectiveness" refers to. Similarly, parents/caregivers probably do not understand what the four achievement levels mean unless they have professional experience in education. Therefore, to ensure fair and transparent evaluation, the four achievement levels are not intended to be applied, verbatim, to evaluations of student work. Rather, these levels serve as guides for teachers as they use their professional judgement to create success criteria for, and with students, that qualify what it means to achieve Levels 1, 2, 3, and 4.

Establishing Success Criteria: ICE Rubrics (Ideas, Connections, Extensions)

How do teachers develop success criteria for assessment tools that serve the goals of assessment for, as, and of learning? Fostaty-Young and Wilson (2004) developed the ICE Rubric as a generalized assessment method for use across various types/ages of students, subjects, and levels of schooling, for all three purposes of assessment. Their method evolved in response to educators' growing awareness that assessments of how much a student had learned were not the same as how well a student had grown in his or her understanding, and that students who knew many facts were not necessarily the ones who accomplished the best learning (Fostaty-Young & Wilson, 2004).

ICE places student learning on a continuum by describing the quality and depth of a student's understanding (from superficial to deep) at different phases of development. Table 8 details the characteristics of learning for each of these phases.

Table 8: ICE Framework: Ideas, Connections, Extensions (Fostaty-Young & Wilson, 2004)

Ideas revealed when learners describe:	**C**onnections are drawn when learners:	**E**xtensions are revealed when students:
• the fundamentals • basic facts • vocabulary/definitions • details • elemental concepts	• 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…"	• 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?"

Teachers can use the characteristics in Table 8 as basic guiding principles when designing ICE rubrics for specific assessment contexts, both formal (projects, assignments) and informal (KB Circles, small group interaction, Inquiry Lab Book entries). Fostaty-Young and Wilson (2000) also encourage teachers, especially in the junior grades, to describe the ICE Framework process to their students and give the class opportunities to create ICE rubrics together, making the purpose and goals of assessment that much more meaningful for learners.

With the guiding principles in Table 8 in mind, teachers can involve students in the creation of assessment tools by asking them probing questions such as:

- "What words or facts do you think are most important for helping us understand the conservation of energy?" (IDEAS)
- "What are the most important ways that you feel energy affects your life and the lives of other beings on the planet?" (CONNECTIONS)
- "What do you think are the most important things we can do to conserve energy? (EXTENSIONS)

The ideas shared by the class can be used to create an assessment tool such as the one shown in Figure 7. Students can use this rubric as a self-assessment tool to evaluate their own work. Using "I can" statements and student-friendly language keeps the evaluation experience a positive one.

Figure 7: Example of Junior-level ICE Rubric for "Where do sources of energy come from?"

ELEMENTS / CATEGORIES	IDEAS	CONNECTIONS	EXTENSIONS	
	Level 1	Level 2	Level 3	Level 4
• *Knowledge and understanding (facts, terminology, definitions concepts)*	• I can give a basic definition for the meaning of renewable and non-renewable resources	• 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	• I can propose suggestions for conserving energy	• I can explain what I might do differently • I can explain what others can do
• *Communication (expression and organization of ideas and information)*	• 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	• I can expand my thinking by connecting ideas to information from my own experiences and other sources	• I can explain how and why my thinking has changed	• I can ask new questions • I can invite my classmates to participate

The success criteria described beneath each phase of the ICE continuum clarify (both for the teacher and learner) the student's level of understanding, as well as his or her strengths and areas for improvement. The criteria are intended to help learners move forward in their growth, and describe the specific learning processes that students are encouraged to demonstrate. Of primary concern is what the student does with the content rather than on the possession of content alone (Strong & Fostaty Young, 2007). See page 146 for another example.

Branch II: Experiential Learning

Learning **about** the Environment, **for** the Environment, and **in** the Environment

> *"Basic understanding begins with exploring how things happen. Observing how things happen in the natural world is the basis of some of the most ancient and spiritually profound teachings of Indigenous cultures. Nature is the first teacher and model of process. Learning how to see nature enhances our capacity to see other things."*
> – Gregory Cajete, *Look to the Mountain: An Ecology of Indigenous Education* (1994)

1. Theoretical Underpinnings

What is Experiential Learning?

Learning through direct experience (or 'doing') is integral to successful learning across all stages of life, from infancy through to the senior adult years. Teacher Candidates, for example, benefit significantly from practical, hands-on experience in real classrooms with real students. This is precisely why practicum placements are an essential component of all accredited Faculty of Education programs in Ontario and a requirement for professional certification with the Ontario College of Teachers.

At its core, **Experiential Learning** can be defined as a process that:

- engages students in direct and active interactions with objects or phenomena in the immediate environment, usually through the use of one or more senses (observing, feeling, hearing, smelling, tasting, and intuition)
- moves away from textbooks as the central or sole repository of knowledge
- involves a continuous exchange between students' immediate experiences and their personal reflections in order to reassess previously held beliefs and influence future experiences and behaviour (Dewey, 1938)
- seeks to transform experience into newly-formed knowledge (Kolb, 1984)

The Inquiry Thread: Inquiry and Experiential Learning

As Dewey (1938) and Kolb (1984) suggest, concrete experience alone does not amount to Experiential Learning. To transform experience into new knowledge, students need to derive meaning from that experience. They do so by reflecting upon its connection to their own current understandings. Conscious engagement with direct experience is precisely where Experiential Learning and Inquiry-based Learning converge. This convergence is illustrated in Kolb's 1984 Experiential Learning Cycle, shown in Figure 8, which identifies a cyclical learning path of experiencing, reflecting, thinking, and acting.

Figure 8: Kolb's (1984) Experiential Learning Cycle

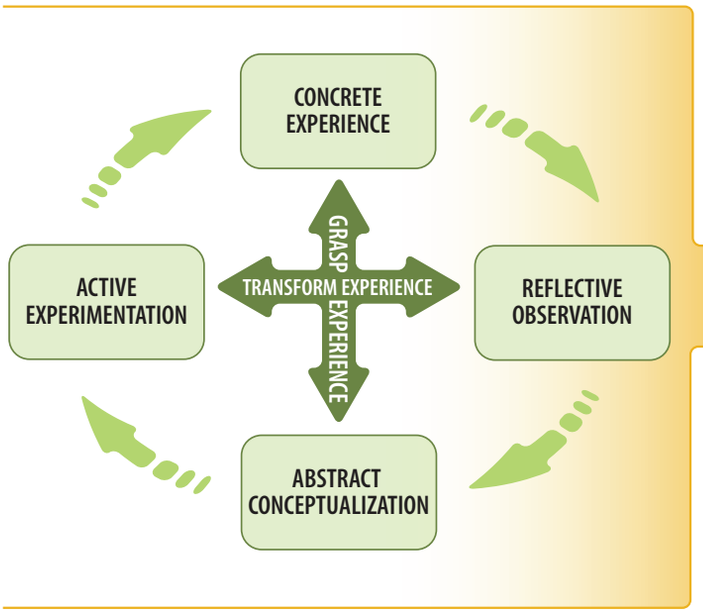
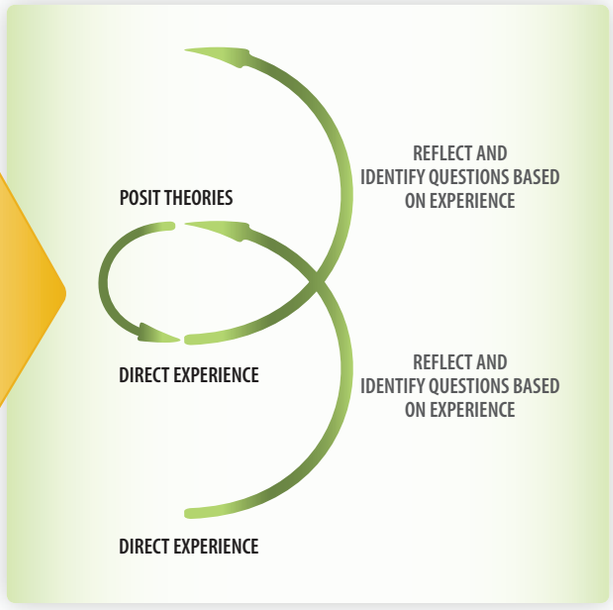


Figure 9: The Experiential-Inquiry Spiral



However, Kolb's 1984 model does not fully express the manner in which Experiential and Inquiry-based Learning processes interact for two main reasons:

- **Cycles are generally self-contained in their scope**, which limits the potential for shifting learning in new directions or contexts
- **Cycles follow a fixed path**, thus limiting a teacher's ability to respond to unanticipated student questions, ideas, or interests

Aware of these limitations, Kolb and Kolb (2008) re-envisioned the learner's movement as a progression along a spiral. Figure 9 depicts a more accurate representation of the symbiotic relationship between Experiential Learning and Inquiry-based Learning: a continuous, upward spiralling of intertwined processes.

"One of the chief beauties of the spiral as an imaginative conception is that it is always growing, yet never covering the same ground, so that it is not merely an explanation of the past, but is also a prophesy of the future; and while it defines and illuminates what has already happened, it is also leading constantly to new discoveries" (Cook, 1914, as quoted in Kolb & Kolb, 2008, p. 311). Immersion in a direct, hands-on experience can serve as both the inspiration for, and outcome of, inquiry-based processes that harness students' questions to advance their learning. For example, Environmental Inquiry might unfold as follows:

- Teachers stimulate students' curiosity about a topic by providing them with an opportunity to participate in an open-ended, direct experience.
- Students reflect on that experience and identify questions for investigation.
- Students posit and record their initial explanations about their wonderings.
- Students then engage in hands-on experiences as one of the key methods through which they pursue their questions.
- Students reflect on their experiences and seek ways to reconcile their reflections and their initial beliefs.
- Students may then identify new questions as a result of their recent experience, or may choose to explore their original questions more deeply from a different perspective.

This dynamic interchange of experience, reflection, and new questioning is potentially limitless. There is no definitive endpoint to the learning process. Students continually formulate and reformulate their ideas and theories with each added layer of lived experience.

Benefits of outdoor experiential learning

Numerous studies affirm the benefits to children and youth of direct experience with the natural environment (Charles, Louv, Bodner, Guns & Stahl, 2009):

- Children's daily exposure to natural settings improved their capacity to focus and enhanced their cognitive abilities*.
- Children who played outside everyday, regardless of weather conditions, had better motor coordination and concentration compared to children who did not play outside everyday*.
- Academic achievement among youth improved when school curricula was organized around the outdoor environment*.
- The regular practice of nature-based, experiential learning at school significantly improved student outcomes in Social studies, Science, Language Arts, and Math*.
- Increased "greening" of the everyday environment improved the ability of children with symptoms of Attention-Deficit Disorder to manage their symptoms*.
- One study showed that 90 percent of respondents —which included parents, teachers, and principals—reported increased student enthusiasm and engagement in learning that occurred outdoors in comparison to learning indoors. 70 percent of respondents also reported increased motivation for teaching that occurred outdoors in comparison to teaching indoors.*

* Source: *Children and Nature 2009: A Report on the Movement to Reconnect Children to the Natural World*

2. Putting it into Practice

Take Your Students Outside!

The outdoors offer students a range of opportunities to use all of their senses, to learn through doing, as they explore the world around them. The Ontario Ministry of Education policy framework, *Acting Today, Shaping Tomorrow* (2009a, p. 6), articulates a vision for Environmental Education as follows: "Students will come to understand our fundamental connections to each other and to the world around them through their relationship to food, water, energy, air and land, and our interaction with all living things".

Yet, for students to understand their fundamental connections with all living things, they need opportunities to connect directly with the environment, and to reflect on that experience. As teachers, we cannot expect students to connect with the environment if we confine them, and our teaching approaches, to the prescribed boundaries of classroom walls, worksheets, and textbooks.

Lost opportunities for direct experience invariably lead to 'default' teaching options, as David Sobel, Director of the Center for Place-based Education at Antioch University, describes: "When direct experience in nature falls to the wayside, the opportunity to explore the ditch gets replaced by memorizing lists of the plants you might find if you actually ever went to the ditch" (2008, p. 11).

Tried and True Examples of Direct Experiences

Teachers who practice Inquiry typically encourage their students to engage in a number of direct experiences (See Table 10), both within and outside the classroom. These types of experiences stimulate the kind of reflection and idea improvement exemplified in the Experiential-Inquiry Spiral (See Figure 9).

Table 10: Inventory of Direct Experiences Used to Foster the Ongoing Experiential-Inquiry Spiral

Type of Experience	Explanation	Examples in Practice
Close Observations of nature or naturally occurring phenomena	Close observations stimulate student curiosity, enhance attention to detail, and compel students to confront their existing understandings in light of observable evidence.	• Amanda's Story: JK/SK, p. 125 • Cindy's Story: Grade 2, p. 80 • Rhiannon's Story: Grade 2/3, pp. 132-133 • Robin's Story: Grade 3, p. 86
Designing experiments	To test their theories, students actively participate (with teacher facilitation) in the process of designing and refining experiments.	• Carol's Story: SK, pp. 67-69 • Perri's Story: JK/SK, pp. 105-107 • Ben's Story: Grade 5/6, pp. 96-98
Open-ended exploration of an outdoor environment	Students use sensory perception to gather information which is used for later questioning and Knowledge Building.	• Amanda's Story: JK/SK, pp. 119-120 • Susanna's Story: Grade 1/2, p. 135 • Cindy's Story: Grade 2, p. 75 • Ben's Story: Grade 5/6, pp. 93-94
"Science-in-the-hand"	Students engage in tactile exploration of objects and materials by touching them with their hands.	• Rhiannon's Story: Grade 2/3, p. 128 • Robin's Story: Grade 3, p. 85 • Vessna's Story: Grade 4, p. 113
Artistic design (building models, drawing, sculpting)	Students express their understanding in visual and tangible ways.	• Carol's Story: SK, p. 66 • Robin's Story: Grade 3, p. 92 • Vessna's Story: Grade 4, p. 116
Role playing	It is not always possible to explore the environment directly depending on the topic of inquiry. Role-play places students in a simulated environment, allowing them to imagine and reflect upon the kind of issues, emotions, and perspectives that may occur through interaction with the real environment.	• Ben's Story: Grade 5/6, p. 101
Active engagement in field research	Wherever possible, students are encouraged to actively participate in multi-source research, and to engage with the topic and environment from many entry points (e.g., conducting interviews, collecting data, and analyzing information).	• Vessna's Story: Grade 4, p. 114-116
Field Trips to off-site locations (e.g., museums, provincial parks, science centres)	Field trips are used to activate students' curiosity at the beginning of an Environmental Inquiry, or as one of many opportunities for students to investigate their questions while in the midst of an inquiry. Rarely, if ever, are field trips solely reserved for the end of a unit.	• Cindy's Story: Grade 2, p. 74-75 • Amanda's Story: JK/SK, p. 125

Field trips: Sending the right message?

Outdoor environments for Experiential Learning can range from a forest trail or ravine to an urban park or school garden carved out of asphalt (Louv, 2008, p. 206). Opportunities for outdoor Experiential Learning are available to schools located in both rural areas bordering on conservation areas *and* schools in urban settings.

Full-fledged field trips to natural settings in distant locations are worthwhile experiences for students for the following reasons:

- Field trips broaden students' horizons. They give students an opportunity to explore new environments beyond the everyday and, in turn, consider the differences and similarities between local and distant environments.
- Field trips give students a chance to gain direct contact with environments, objects, or events that are not accessible within the school community.
- Field trips that involve facilitators/guides or expert speakers allow students to learn from an adult, other than their classroom teacher, who may have specialized knowledge.
- Excursions provide opportunities for less advantaged students to experience environments that may not otherwise be accessible to them.

However, field trips are not a panacea for outdoor Experiential Learning. Relying too heavily on one-time events to locations that are not readily accessible for all learners due to socio-economic background, geographic location, culture, or ability, potentially signals the wrong message: that the environment is something far away, detached from and irrelevant to their everyday lives. Teachers, therefore, need to be wary about perpetuating this misconception.

Explore the Local Community and You'll Find the Curriculum!

Ideally, field trip experiences should occur *in combination* with frequent outdoor learning experiences within the local school community. As Sobel (2008) emphasizes, learning begins with understanding one's own environment in the familiar world of neighbourhoods and communities.

Children attach value to places and experiences that are familiar and relevant to their everyday lives. Therefore, when teachers afford students regular opportunities to "get to know" the surroundings of their school, they help to foster students' sense of place and their understanding of the relevance of community in their lives.

Some teachers, especially those in urban schools, may assume that the outdoor surroundings of their school offer few, if any, meaningful opportunities for students to engage with the natural environment. Yet, all teachers need to do is look outside their doors to find a world of opportunities!

Yet, inspiring experiential opportunities can easily occur in 'unnatural' contexts. Zenobia Barlow, Executive Director and co-founder of the Center for Ecoliteracy, describes one such experience:

"We explored a three-block radius of neighbourhood around the school for half an hour. I asked the students to write three lines of poetry or narrative based on what they observed, and bring back a found object. We then used the writing they brought back to create a poem, and we placed the found objects on an oversized map of the school and its surroundings. The results were incredible. You don't need to be in the wild to use the environment for learning. Life is erupting everywhere. Weeds grow out of cracks in cement...Many urban campuses are covered with asphalt, but even there, one can still find a special place. Children have this tremendous ability to focus on minute things. If you're small yourself, you're more likely to see all these other tiny life forms – ants and such – that the rest of us pass by" (Barlow, 2002, as quoted in Jenson 2002, p. 6).

Teachers from The Laboratory School at The Dr. Eric Jackman Institute of Child Study use a wide range of outdoor spaces, both within the schoolyard and in nearby outdoor spaces, to facilitate

Experiential Learning within the larger framework of Environmental Inquiry. They manage to do so in a very urban context. Located in the centre of downtown Toronto, The Lab School has a modest-sized schoolyard, the ground cover of which is two-thirds concrete and one-third wood chips. There is also a small fenced-in courtyard, which serves as an outdoor play area for the school's three and four-year-olds, where various plants and weeds crop up from a narrow dirt path along the fence.

- Carol Stephenson, Senior Kindergarten teacher, chose Sibelius Park for an experiential learning environment. Located only 300 meters from the school, in a densely populated residential area, the park has a well-manicured lawn (when the season permits) and perhaps a dozen trees. Although obviously not the embodiment of wilderness biodiversity, this urban space ignites the curiosity of her students, time and again. Through regular visits to Sibelius Park, the students have observed, touched and smelled the trees, thereby engaging in direct experiences that have served to develop their understanding of how trees change throughout the seasons (See pages 66-67 for a full description).

- Zoe Donahue, Grade 1 teacher, chose a particular tree in the schoolyard that she felt would best exemplify how trees change with the passing seasons. To document these changes, the students sketched and photographed the tree once a month throughout the school year as a basis for reflection and Knowledge Building (See photo 8).

- Ben Peebles and his Grade 5/6 students launched an Environmental Inquiry into biodiversity by spending an hour or so digging along a narrow path of weeds in the school's courtyard. The plant life from this path proved to be more than "just a bunch of weeds". Later on, the students designed experiments using the plants as their subject of inquiry (See page 93 for a full description).

Photo 8: Noticing and Documenting Change

Teachers at other Toronto schools have also been successful:

- Rose Avenue Junior Public School is located in a very densely populated community, in close proximity to 22 high-rise apartment buildings. However, this ultra urban setting did not deter Kathleen Quan and her Grade 4/5 students from engaging in an innovative and meaningful outdoor learning experience that benefitted the entire school community: transforming a portion of the schoolyard into an edible garden (See pages 140-146 for a full description).

Photo 9: Rose Avenue Public School Community

'Unnatural' Outdoor Spaces: Why They Count

There is much learning to be gained from bringing students outside, even if the school surroundings seem far from 'natural'. The dramatic disproportion between the built and natural environments in urban communities is an important observation for students to make, and can lead to deeper questions about the impact of urban development on ecosystems.

For instance, Ben Peebles' Grade 5/6 students noticed that there were far fewer forms of wildlife in their schoolyard compared to what they encountered in Sandbanks Provincial Park (See page 94). This observation led one group of Grade 5 students to choose urban sprawl as the topic of their environmental awareness documentary, which they created in the final term of the year (See page 102).

One might assume that Rose Avenue Public School has few opportunities for outdoor experiential learning because it is surrounded by high-rises and has a field made of artificial turf instead of natural grass. On the contrary, it offers an important perspective for investigation: the co-existence of natural and urban built environments. An exploration of this particular schoolyard might lead to questions such as:

- "Why isn't there real grass here?"
- "Can we grow grass here?"
- "What could we do to find out?"
- "Where can we create more natural spaces around our school?"

Community walks

As teachers have found, taking students on community walks in search of physical evidence about a particular topic of inquiry can serve to heighten children's awareness of their local surroundings. Additionally, it opens up numerous curriculum connections including number sense and numeration, geometry, structures, simple machines, flight, energy, matter, growth and change, daily and seasonal changes, habitat, air, water, soil, history, art and more!

Social justice connections

Exploring the local community can also inspire investigations into social justice issues. During her Structures and Mechanisms unit, Rhiannon Kenny brought her Grade 2/3 students on a community walk to identify different structures in the neighbourhood (See Photo 10). The class then engaged in a Knowledge Building Circle to discuss the question: "Of the structures that you spotted, what kind of structure is the most important in your life?" Not surprisingly, the Grade 2/3s identified houses as the most essential structures in their lives. Through writing and drawing, they conveyed their personal reflections on the importance of home.

The combined experiences of community walks, Knowledge Building Circles and individual reflections served to shift the focus of the Grade 2/3s' inquiry into Structures. The children became interested in social justice issues such as the lack of affordable housing, homelessness, and sub-standard housing in Toronto and Canada.

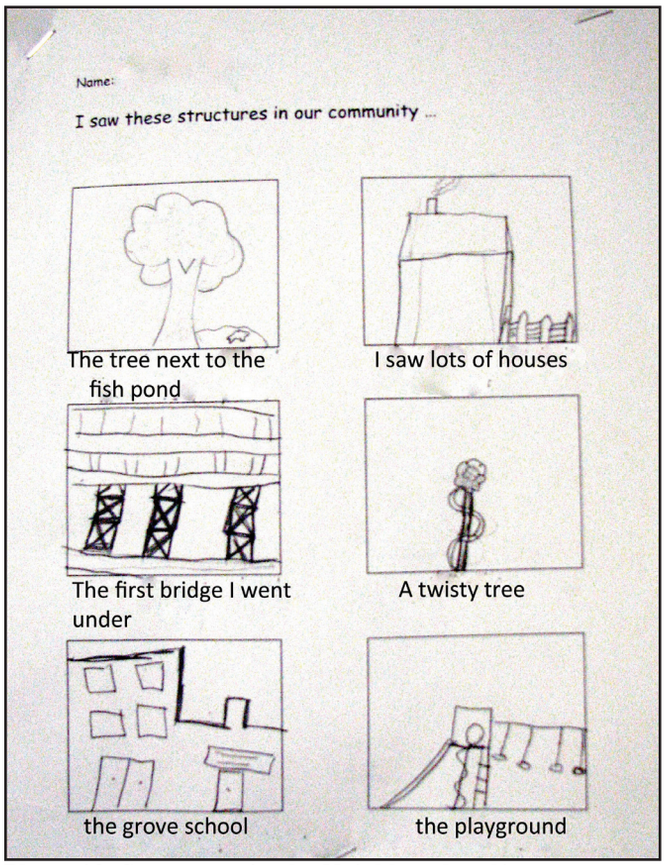


Photo 10: Structures in the Neighbourhood*

* Text enhanced to ensure legibility. Original grammar has been maintained.

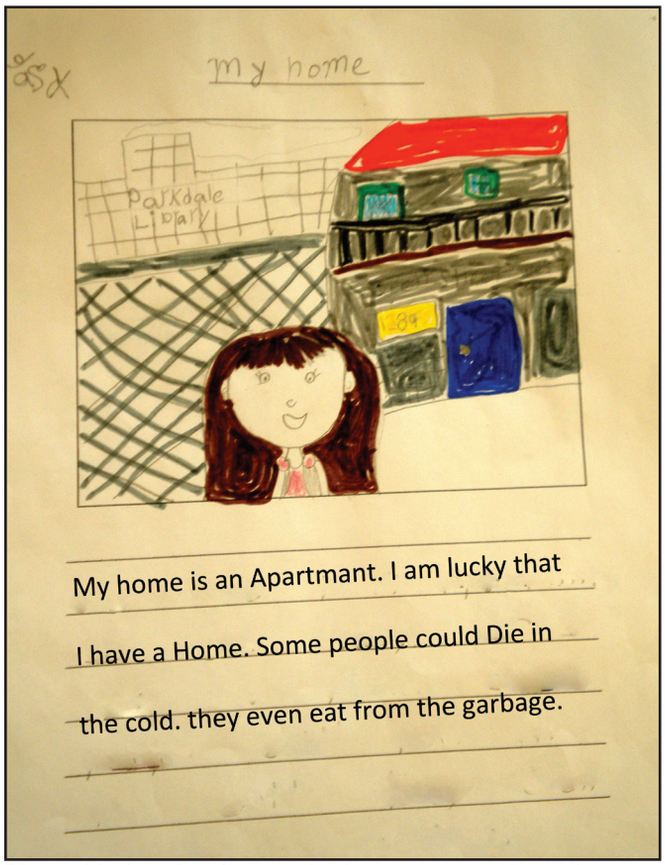


Photo 11: A reflection on the importance of home*

* Text enhanced to ensure legibility. Original grammar has been maintained.

Branch III: Integrated Learning

Seeing the Big Picture

"All education is environmental education. By what is included or excluded, students are taught that they are part of or apart from the natural world. We must be wary not to imprint a disciplinary template onto impressionable minds and with it the belief that the world really is as disconnected as the divisions, disciplines, and sub-disciplines of the typical curriculum. Students come to believe that there is such a thing as politics separate from ecology or that economics has nothing to do with physics. It just happens to be dead wrong. The same is true throughout the curriculum."

– David Orr, *Earth in Mind: On Education, Environment, and the Human Prospect* (2004)

1. Theoretical Underpinnings

What is Integrated Learning?

Integrated Learning is an approach that seeks to make learning 'whole' and is based on a holistic view of education. "It recognizes the necessity for learners to see the 'big picture' rather than to require learning to be divided into small pieces" (Brazee & Capelluti, 1993, citied in Brazee & Capelluti, 1995, p. 10).

Integrated Learning transcends disciplinary borders. Subject lines are blurred as teachers encourage students to make connections between disciplines and draw upon content and skills from multiple subject areas.

The Benefits of Integrated Learning

The benefits to students of this interconnected view of the curriculum include:

- a stronger grasp of each subject's purpose and varied applications, in different contexts
- a deeper understanding of any one topic by exploring it through multiple perspectives
- a greater appreciation for the integrated manner in which subjects, skills, ideas, and different perspectives connect to the larger world
- improved skills in systems-thinking

Children spend nearly half of their daily waking hours at school, an environment that ultimately shapes a large portion of their experience and understanding of the world. By making the learning experience at school 'whole' through Integrated Learning, a student's outlook of the larger world can also be made 'whole'. Learning to see the interconnections of all aspects of life ultimately becomes a habit-of-mind that will serve them well throughout their lives.

Implications for Environmental Inquiry

The environment is fundamental to the functioning of all global systems – economic, political, social, and cultural. Students are better able to grasp the relationship between the environment and these other facets of life when Environmental Education is integrated throughout their learning, rather than 'added on'. Students need to develop an understanding of the environment's infinite connections if they are to make informed, sustainable life choices. Environmental Inquiry provides a lens through which to view the curriculum and facilitates the process of making linkages both within and between disciplines. For teachers who are just beginning to integrate learning in their programs, connecting topics to the

environment is a great place to start!

Although the world functions on an integrated basis, formal education tends to reinforce the fragmentation of knowledge into discrete disciplines of study. While this is not ideal, a focus on distinct disciplines or units of study also has its place and purpose, enabling teachers to:

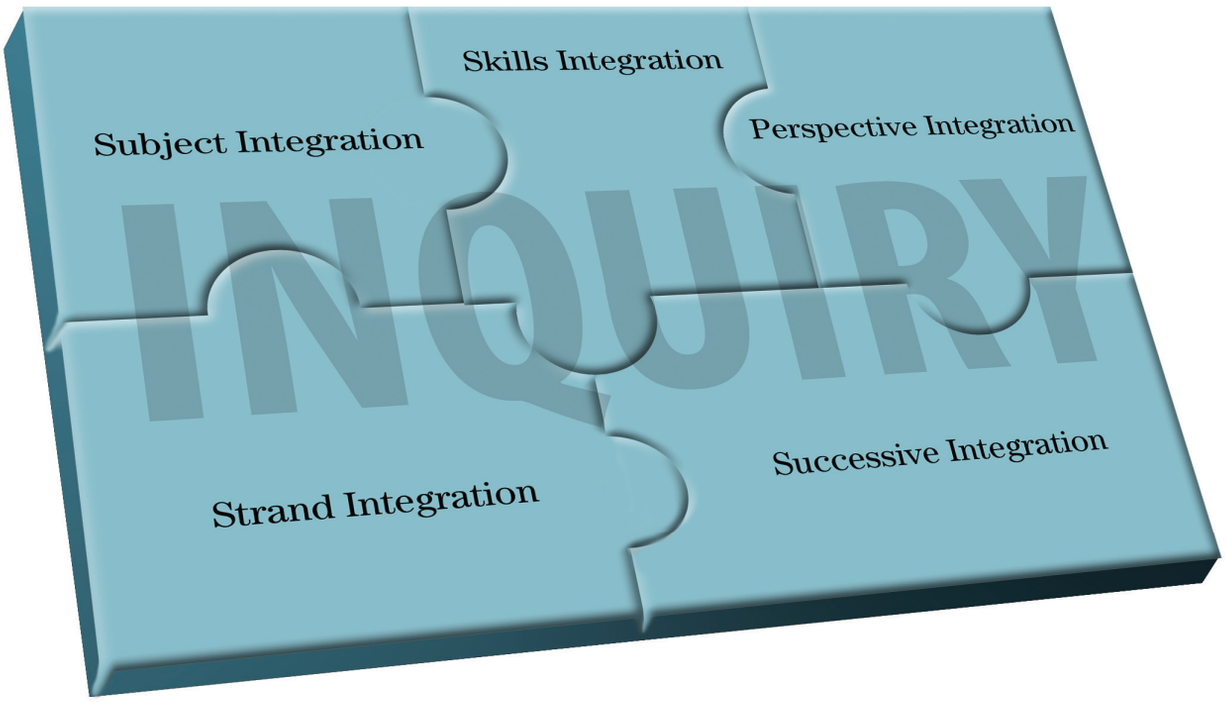
- emphasize concepts and skills specific to a particular discipline that are needed for students to solve particular problems or questions
- establish an initial knowledge base in instances where students have demonstrated limited or no prior knowledge of a particular topic
- introduce a discrete topic and gradually, throughout the unit, scaffold students' learning toward connecting with other disciplines, issues and/or perspectives

However, when students' exposure to the curriculum is limited only to learning discrete subject areas at the expense of Integrated Learning, their perceptions about the world, its complexity and interconnectedness, is likewise limited and potentially skewed. Students also need open-ended opportunities to integrate their knowledge and skills from different disciplines and, importantly, to think critically about how all of those pieces fit together. Educators, cannot expect students to approach problems in multiple ways, or appreciate perspectives other than their own, if they are not provided with opportunities for Integrated Learning.

Building an Integrated Learning Program

There are a number of different ways to build an Integrated Learning program. The teachers profiled in this resource have used five distinct strategies – *Subject Integration*, *Strand Integration*, *Skills Integration*, *Successive Integration* and *Perspective Integration* – to integrate curricula and learning skills in each of their Environmental Inquiries (See Figure 10). The implementation of each strategy serves to foster children's holistic understanding of the world.

Figure 10: The Integrated Learning Puzzle



Subject Integration

Commonly referred to as multi-disciplinary or cross-curricular learning, Subject Integration is most often associated with Integrated Learning. Students are provided with opportunities to link content from two or more subjects or disciplines within a single unit of study (e.g., Math, Social Studies, Science). For examples, see Carol's Story, pages 70-72; Cindy's Story, pages 77-78; and Ben's Story, page 98.

Strand Integration

Strand Integration provides students with opportunities to explore relationships within a subject area by linking content from two or more curriculum strands. For instance, the Ministry of Education's Science and Technology Curriculum (2007b) is organized into four separate strands: Understanding Life Systems, Understanding Structures and Mechanisms, Understanding Matter and Energy and Understanding Earth and Space Systems. Each strand represents the major areas of knowledge and skills within the subject Science and Technology.

Robin Fogarty argues that "both integration within a discipline and integration across a discipline are necessary to fully integrate the curricula" (1991, p. xiv). Strand Integration is a logical starting place for integrating learning since the strands within a subject are already interrelated within a discipline (See Table 11 for example). If students are to appreciate the complex manner in which the world's sub-systems interact, they would benefit from opportunities to see how smaller systems function within the larger discipline.

Skills Integration

Skills Integration is a strategy intended to help children learn how to learn. It focuses on developing the kinds of essential skills that can be applied to all subjects and strands of the curriculum such as:

- **Critical Thinking and Problem Solving**: predicting; hypothesizing; categorizing; inferring; synthesizing; comparing and contrasting; generalizing; evaluating conflicting priorities; suggesting alternatives; making informed decisions
- **Social/Communication Skills**: listening attentively; agreeing or disagreeing with others in a respectful manner; paraphrasing; communicating ideas in a coherent manner; acknowledging and respecting the perspectives of others; cooperating with others during collaborative work or play
- **Organization**: brainstorming; sequencing ideas logically; planning how best to express understanding (e.g., written, oral, visual or dramatic); managing time; planning a game in play-based situations
- **Application**: applying previously learned information or skills to new situations (e.g., research skills, reading comprehension, measurement skills)

These lifelong learning skills are the keys that enable students to access and interact with the entire curriculum. They are also applicable in day-to-day life. The pervasive application of these skills throughout, and even beyond a student's educational career, suggest that Skills Integration is an essential piece of the Integrated Learning Puzzle (For examples, see Robin's Story, page 92; and Cathy's Story, pages 150-152).

Successive Integration

In Successive Integration the teacher creates opportunities for students to explore relationships between consecutive topics of study. This is done by arranging units in a particular order, and creating bridges between topics rather than bringing units to an abrupt halt. To illustrate: Cindy Halewood, Grade 2 teacher, decided that the Grade 2 Environmental Inquiry into trees and forests would be followed by an Environmental Inquiry on North Atlantic salmon. Rather than say to her students, "Our study of trees and forests is complete. It's time for us to study salmon," Cindy asked a question that encouraged her students to think about the relationship between these two topics: "How do you think trees might be connected to salmon?" (See Cindy's Story, page 81; and Ben's Story, page 100).

Perspective Integration

Perspective Integration involves the exploration of a topic from different points of view. When students examine topics from different perspectives, they are more empathetic to the plight of others affected by various actions, events, and decisions (such as armed conflict, oil spills and excessive consumer spending).

The 'environmental perspective' has long been under-valued and often overlooked in many fields of endeavour. Deforestation, habitat loss, the growing number of extinct species, and a rapidly changing global climate, are among the consequences. This generation of students is being asked, more than ever before, to embrace this perspective: to consider how human decisions, behaviours and actions positively and negatively impact the sustainability of the planet.

The Ministry of Education's policy document, *Acting Today, Shaping Tomorrow* (2007), strongly urges teachers to integrate Environmental Education throughout the curriculum. This also affirms the importance of Perspective Integration: Students are asked to look at topics through an environmental lens, and to consider the perspectives of the Earth's animal and plant species and the interrelationships integral to their survival.

To gain a holistic view of the world, students need to make the link between this green perspective and other critical global issues. This link needs to be made explicit. Perspective Integration sets the stage for this process. Moreover, the definition of sustainable development put forth by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) underscores the importance of an integrated perspective: "Sustainable development is a vision of development that encompasses populations, animal and plant species, ecosystems, natural resources and that integrates concerns such as the fight against poverty, gender equality, human rights, education for all, health, human security, intercultural dialogue, etc". (1995, www.unesco.org/en/esd).

For students, an important first step is to recognize that their own perspective is shaped by prior knowledge, experiences, culture, family structure and other factors. Students also need to appreciate that studying a topic from a single perspective provides only an incomplete picture and can result in misinformed opinions and imbalanced decisions. Therefore, teachers need to encourage their students to see multiple perspectives, on any given topic, and to recognize that others' opinions, even those different from their own, have value.

Putting the Pieces Together: Getting Started

It would be impractical, if not impossible, to implement each of these Integrated Learning strategies all at once. A more pragmatic way to begin is to assemble 'the puzzle' gradually over the course of a school year. Such was the experience of the teachers profiled in Part 2 of this resource. These teachers wisely chose to incorporate where appropriate, not all, but at least one or two forms of Integrated Learning at a time.

The process of building an Integrated Learning program is not linear, and the various strategies need not be implemented in a particular order. Certain forms may be used more frequently than others, or in different combinations, until teachers fully grasp how the pieces fit together in different curricular contexts. Below are some strategies that teachers may use to gradually build an Integrated Learning program in their classrooms.

- A teacher might begin by focusing on one piece of the puzzle until he or she achieves a desired comfort level with it before adding another piece of the puzzle.
- A teacher may use a couple of approaches simultaneously, at different times within a unit, or across different units.
- Some teachers may consistently apply one form of Integrated Learning throughout the year, and gradually assemble other "pieces" along the way.

- Some teachers will find that the topic, or the questions that students have posed in an inquiry immediately lend themselves to several "pieces" of Integrating Learning in one unit.

Deciding which pieces of the Integrated Learning puzzle to bring to the program requires continuous reflection on the part of the teacher. Teachers may want to reflect on a couple of key questions throughout the planning process, such as:

- *"Which Integrated Learning approaches would fit the context of this current topic of study?"*
- *"Which pieces of the puzzle can I foresee adding throughout this unit of study?"*

The Inquiry Thread: Inquiry and Integrated Learning

Teachers need to balance subject-driven and student-driven learning goals when planning an Integrated Learning program. Since the primary goal of Integrated Learning is to link the curricula's various subjects and strands, there is the risk that teachers may inadvertently, during the planning process, push students' questions and ideas to the periphery of the learning experience.

For this reason, it is important that Inquiry remain a central feature of Integrated Learning. Teachers in an inquiry-based environment continually seek opportunities to integrate learning, but not at the expense of their students' ideas, interests and curiosity. Instead, they use students' questions as the catalysts for creating authentic integrated learning experiences that capitalize on students' sense of wonder and enthusiasm for learning. They continuously reflect on the question: *"How can I integrate what students are curious about into my planning?"*

How can teachers integrate what students are curious about into their planning?

Unlike the typical curriculum, students' questions and ideas are not organized into discrete disciplinary compartments. When presented with a broad concept or topic to explore, students typically ask questions that cross subject lines and disciplines. Therefore, Inquiry can open the way for an organic approach to Integrated Learning that develops from students' questions.

Teachers can create an integrated learning program by "mapping" their students' questions onto different subjects or strands in the curriculum. This responsive process, as shown in Tables 11 and 12, reveals the many possibilities for Integrated Learning that arise when students' questions are placed at the centre.

Tables 11 and 12 illustrate how a Grade 2 class' questions about water led to opportunities for Strand Integration and Subject Integration respectively. It is important to note that the students' questions were linked to the curriculum's overall expectations, for two main reasons:

- Focusing on broader ideas, issues or concepts (rather than on more narrow specific expectations) creates more room for students to pose and pursue relevant and exciting questions
- The Ministry of Education now asks teachers to focus their evaluation on students' achievement of the overall expectations (Growing Success, 2010)

Given the magnitude of curriculum connections (as shown in Tables 11 and 12), teachers can pursue many options to address the curriculum's overall expectations. However, they will need to know the curriculum well if they are to connect students' questions and ideas to different subjects or strands of the curriculum.

Table 11: Integrating Students' Questions into the Curriculum: STRAND Integration in Grade 2

STUDENTS' QUESTIONS	LINKS TO THE ONTARIO CURRICULUM – *SCIENCE AND TECHNOLOGY: GRADE 2 (2007b)*	
	Strand & Topic	Big Idea (BI) and Overall Expectation (OE)
Why is a lot of water polluted?	**Strand:** Understanding Earth and Space Systems **Topic:** Air and Water in the Environment	**BI:** "Our actions affect the quality of air and water, and its ability to sustain life." **OE:** "Changes to air and water affect living things and the environment."
	Strand: Understanding Life Systems **Topic:** Growth and Change in Animals	**BI:** "Humans need to protect animals and the places where they live." **OE:** "Assess ways in which animals have an impact on society and the environment, and ways in which humans have an impact upon animals and the places where they live."
Why do so many species live in water?	**Strand:** Understanding Earth and Space Systems **Topic:** Air and Water in the Environment	**BI:** "Air and water are a major part of the environment." **BI:** "Living things need air and water to survive." **BI:** "Changes to air and water affect living things and the environment." **OE:** "Demonstrate an understanding of the ways in which air and water are used by living things to help them meet their basic needs."
	Strand: Understanding Earth and Space Systems **Topic:** Growth and Change in Animals	**BI:** "Humans need to protect animals and the places where they live." **OE:** "There are similarities and differences among different kinds of animals."
How do snowflakes form themselves?	**Strand:** Understanding Earth and Space Systems **Topic:** Air and Water in the Environment	**BI:** "Changes to air and water affect living things and the environment." **OE:** "Investigate the characteristics of air and water and the visible/invisible effects of and changes to air and/or water in the environment."
What part of our bodies is water?	**Strand:** Understanding Earth and Space Systems **Topic:** Air and Water in the Environment	**BI:** "Air and water are a major part of the environment." **BI:** "Living things need air and water to survive." **OE:** "Demonstrate an understanding of the ways in which air and water are used by living things to help them meet their basic needs."
	Strand: Understanding Earth and Space Systems **Topic:** Growth and Change in Animals	**BI:** "Animals have distinct characteristics." **BI:** "Humans are animals." **OE:** "Investigate similarities and differences in the characteristics of various animals."
Why does everything need water?	**Strand:** Understanding Earth and Space Systems **Topic:** Air and Water in the Environment	**BI:** "Air and water are a major part of the environment." **BI:** "Living things need air and water to survive." **OE:** "Demonstrate an understanding of the ways in which air and water are used by living things to help them meet their basic needs."
	Strand: Understanding Earth and Space Systems **Topic:** Growth and Change in Animals	**BI:** "There are similarities and differences among different kinds of animals." **OE:** "Investigate similarities and differences in the characteristics of various animals."
Why do some fish live in salt water while others live in fresh water?	**Strand:** Understanding Earth and Space Systems **Topic:** Air and Water in the Environment	**OE:** "Demonstrate an understanding of the ways in which air and water are used by living things to help them meet their basic needs." **OE:** "Investigate similarities and differences in the characteristics of various animals."
	Strand: Understanding Earth and Space Systems **Topic:** Growth and Change in Animals	**BI:** "Animals have distinct characteristics." **OE:** "Investigate similarities and differences in the characteristics of various animals."

Table 12: Integrating Students' Questions into the Curriculum: SUBJECT Integration in Grade 2

STUDENTS' QUESTIONS	LINKS TO THE ONTARIO CURRICULUM – *SOCIAL STUDIES: GRADE 2 (2004)*	
	Strand & Topic	Big Idea (BI) and Overall Expectation (OE)
Why does everything need water?	**Strand:** Canada and World Connections **Topic:** Features of Communities	**OE:** "Explain how the environment affects people's lives and the ways in which their needs are met." **OE:** "Describe some similarities and differences in the ways communities around the worlds meet their needs.

STUDENTS' QUESTIONS	LINKS TO THE ONTARIO CURRICULUM – *MATHEMATICS: GRADE 2 (2005)*	
	Strand	Key Mathematical Skills (KS) and related Overall Expectations (OE)
Why do so many species live in water?	**Strand:** Data Management and Probability **Topic:** Data Relationships	**KS:** "Read and display data using line plots and simple bar graphs." **OE:** "Read and describe primary data presented in tally charts, concrete graphs, pictographs, line plots, simple bar graphs, and other graphic organizers."
How do snowflakes form themselves?	**Strand:** Geometry and Spatial Sense **Topic:** Geometric Properties	**KS:** "Compose and Decompose Shapes." **KS:** "Locate a line of symmetry." **OE:** "Compose and decompose two-dimensional shapes and three-dimensional figures."
What part of our bodies is water?	**Strand:** Number Sense and Numeration **Topic:** Quantity Relationships	**KS:** "Investigate fractions of a whole." **OE:** "Read, represent, compare, and order whole numbers to 100, and use concrete materials to represent fractions…"
Why do some fish live in salt water while others live in fresh water?	**Strand:** Number Sense and Numeration **Topic:** Quantity Relationships	**KS:** "Investigate fractions of a whole" **OE:** "Read, represent, compare, and order whole numbers to 100, and use concrete materials to represent fractions…"
	Strand: Data Management and Probability **Topic:** Data Relationships	**KS:** "Organize objects into categories using two attributes." **KS:** "Read and display data using line plots and simple bar graphs." **OE:** "Collect and organize categorical or discrete primary data and display the data, using tally charts, concrete graphs, pictographs, line plots, simple bar graphs, and other graphic organizers, with labels ordered appropriately along horizontal axes, as needed." **OE:** "Read and describe primary data presented in tally charts, concrete graphs, pictographs, line plots, simple bar graphs, and other graphic organizers."

2. Putting it Into Practice

Flexible Long-Term Planning

Successive Integration suggests that teachers' long-term plans should be designed to ensure that the sequencing of units is conducive to making connections between two or more consecutive topics of study. Although Integrated Learning is about making the curriculum whole by integrating the study of different topics concurrently, it is also about creating logical connections *between* those different topics of study *over the course of the year*. Teachers create a cohesive and connected year of learning by anticipating these kinds of logical connections in advance. For example:

- A Grade 3 teacher may deliberately plan to follow a study of Strong and Stable Structures with Early Settlements in Upper Canada. A possible link between these disciplines (Science & Technology, Social Studies) could be to compare present-day structures to those in the past, and to explore how these different building approaches have affected the environment.
- This same Grade 3 teacher may decide to follow a study of Strong and Stable Structures with a Social Studies unit on Urban and Rural Communities. This sequence could allow students to compare and contrast urban and rural structures, while also investigating the environmental impact of these different structural approaches on urban and rural communities.

Flexibility and responsiveness

As Robin Fogarty has observed: "Just by rearranging the order of topics, teachers can help kids make those critical connections" (1991, p. 35).

In an inquiry-based learning environment, teachers encourage their students to take responsibility for their own learning wherever possible. The fostering of *epistemic agency* (See page 10) is one of 12 Knowledge Building Principles within Inquiry-based Learning that has direct bearing on the issue of long-term planning for the following reason: The connections between units of study are especially relevant for students when the students themselves have identified them. Therefore, teachers need to be flexible in terms of their long-range plans (e.g., the sequencing of units). Yet, nothing is lost, only reconfigured. Moreover, a flexible approach to planning ultimately helps teachers to delve more deeply and creatively into the curriculum.

Example: Grade 5s link government to energy

During their initial study of Government, students in Cathy Bertucci's Grade 5 class posed questions connected to another topic: Energy. Even though Cathy had not planned to begin the topic of Energy for another two months, she rearranged her pre-determined, long-term plans to support the interests and curiosity of her students and to provide an authentic opportunity for *Successive Integration*. (See Cathy's Story on pages 147-148 for a full description).

> *"Subject matter is not discarded: It is re-positioned in a new form."*
> – Edward Brazee and Jody Capelluti, Dissolving Boundaries: Toward an Integrative Curriculum (1995).

Broadening Perspectives

Perspective Integration leads to opportunities for interdisciplinary study – where disciplinary boundaries are blurred in an effort to understand an idea or issue more fully and from various perspectives. The example that follows demonstrates how the Grade 4s at The Lab School explored the Social Studies topic, Canadian Provinces and Territories, from several disciplinary vantage points: Physical Geography, Aboriginal Studies, and Science. The result was a seamless, cohesive trajectory of learning that connected several subject areas within the overarching theme of Canadian Provinces.

The Grade 4s began investigating this topic from a geographic perspective. Each student chose a province or territory to study and began by researching the physical landscape and the types of natural resources found in these jurisdictions. Many of the students developed an interest in the inhabitants that had populated these regions prior to colonialism. This led to a shift in focus: from physical geography to Aboriginal cultures. In groups of three, students investigated the pre-modern history of specific Aboriginal groups to answer a number of questions including: "What type of food did they eat? Where did they get their food? What type of hunting skills did they have? What did their homes look like?"

In the course of their research, the students learned a great deal about the heritage of Aboriginal communities and, through Knowledge Building Discourse, explored the centrality of the natural world to Aboriginal Peoples' worldviews and ways of living. They also discussed the effects of colonialism and 'development' on Aboriginal communities. The question: "What did their traditional homes look like?" led the Grade 4s to shift the focus of their inquiry once again, this time to Structures, but within an Aboriginal context. Working in small groups, the students researched and built models of traditional Aboriginal shelters, using natural and semi-natural materials (e.g., popsicle sticks).

Balancing conflicting priorities

Perspective Integration also leads students to "appreciate the challenges faced by the human community in defining and implementing the process needed for environmental sustainability" (Ontario Ministry of Education, 2009a, p. 27). While most people would agree that environmental sustainability is an essential global priority, achieving this goal is not always straightforward. For instance, while electric cars reduce harmful emissions, building more roads to sustain an automobile culture consumes land and energy in construction and maintenance. How do we reconcile these important priorities?

An important step in achieving a balanced solution is to become familiar with both (and other) perspectives. During their inquiry into Government, the Grade 5/6 students in Ben Peebles' class did just that. Through research and role playing, they simulated the process for drafting legislation designed to restrict car idling. In doing so, they came to understand that diverse constituents in a metropolitan city like Toronto have opposing perspectives on certain issues (See Ben's Story, pages 100-101).

Photo 12: Grade 4s Build Traditional Aboriginal Shelters

Developmental considerations

The ability to see other points of view is undeveloped in young children. Four- and five-year-olds do not fully appreciate that other people hold opinions and feelings different from their own. The ability to understand another person's perspective is a skill that develops throughout childhood and even into adulthood.

Teachers can foster perspective-taking skills in their students by exposing them to frequent and varied forms of social interaction through which they can develop an appreciation for their own ideas, and those of their peers. In the Early Years, these kinds of interactions are often unstructured, such as during 'dress up' or imaginative play. During Knowledge Building Discourse (See page 11), Early Years teachers can also model empathy and respect for idea diversity, by encouraging children to share their thoughts and feelings with others, and to listen and respond to those of their peers.

Integrating Multi-Modal Learning

> *"Fundamental to this kind of teaching and learning is the willingness to work with children "where they are," and to understand with what they are struggling."*
> – National Science Foundation, *Inquiry: Thoughts, Views, and Strategies for the K-5 Classroom* (2001)

Skills Integration not only supports the integration of different disciplines, it also creates opportunities for students to integrate a variety of skill sets (e.g., reading, writing, oral communication, artistic and technological skills). As a result, *Skills Integration* fosters student integration and inclusion. The unique talents, interests, and learning styles of each student are recognized and invited into the learning process. *Education for All: The Report of the Expert Panel on Literacy and Numeracy Instruction for Children with Special Education Needs* states that "classroom teachers in Ontario serve a growing number of students with diverse abilities" and that "teachers need to plan for diversity by giving students tasks that respect their abilities" (Ontario Ministry of Education, 2005b, pp. 2 & 4).

Skills Integration respects student diversity in a manner consistent with the principles of *Universal Design for Learning* (UDL), an inclusive education framework designed by the Center for Applied Special Technology (CAST) to give "all individuals equal opportunities to learn" (CAST, www.cast.org). The UDL model provides students with multiple modes or options through which to access learning, to 'set them up' for success. Table 13 summarizes the principles of UDL and provides examples and classroom applications (with cross-references to the teachers' stories in Part 2 of this resource).

Table 13: Application of Universal Design for Learning (UDL) Principles

UDL Principle*	Definition*	Examples	Application in the classroom (Teachers' Stories)
1. Multiple means of Representation	• Presenting information and content in different ways	• Books (fiction and non-fiction) at different reading levels • Read-alouds • Picture books • Videos • Guest speakers • Books on tape/CD • Opportunities for sensory exploration	• Cindy's Story (p. 74) • Robin's Story (pp. 85-86) • Rhiannon's Story (pp. 128-129) • Susanna's Story (p. 135)
2. Multiple means of Expression	• Differentiating the ways that students can show what they know	• Drawing • Writing • Sculpting • Audiovisual presentations • Graphic representation • Knowledge Building Circles (oral communication) • Creating/building • Technology • Researching a variety of sources, individually or in a group	• Carol's Story (p. 72) • Cindy's Story (p. 78) • Robin's Story (p. 92) • Ben's Story (p. 102) • Vessna's Story (pp. 114-115) • Amanda's Story (p. 122) • Rhiannon's Story (pp. 132-133) • Kathleen's Story (p. 145) • Cathy's Story (pp. 153-154)
3. Multiple means of Engagement	• Establishing different ways for students to engage with a topic in order to keep them motivated	• Allowing students to pursue their own questions! • Knowledge Building Circles • Outdoor experiences/ excursions • Experiments	• Carol's Story (p. 65) • Amanda's Story (pp. 119-120) • Rhiannon's Story (pp. 130-133)

*Source: Center for Applied Special Technology (CAST), www.cast.org

Branch IV: Stewardship

Fostering Civic Responsibility

> *"If we can harness our knowledge, the deep reservoirs of human wisdom accumulated over millennia, and our unique gift of foresight, then we can achieve sustainability within one or two generations. Saving ourselves and countless other species from the brink of ecological disaster would be the greatest comeback of all time."*
> – David Suzuki, *David Suzuki's Green Guide* (2008)

1. Theoretical Underpinnings

What is Stewardship?

In an environmental context, stewardship refers to human actions that contribute to a sustainable future for humans, animals, and plant species alike. Acts of stewardship grow from a deep respect for, and desire to protect, the balance of nature within the Earth's biosphere.

Stewardship of the planet entails civic responsibility because:

- It recognizes that everyone has a shared responsibility to do his or her part to keep the planet healthy
- It parallels a fundamental goal of Education for Sustainable Development (ESD), which is to "encourage changes in behaviour that will create a more sustainable future in terms of environmental integrity, economic viability, and a just society for present and future generations" (ESD, www.esdcanada.ca/what-esd)
- It develops within people "the attitudes, skills and knowledge to make informed decisions for the benefit of themselves and others, now and in the future, and to act upon these decisions" (UNESCO, www.unesco.org/en/esd/)
- It challenges the notion that nature is merely an unlimited system of resources to be extracted for human consumption without consequence

How Can Teachers Foster Stewardship Behaviour?

Teachers can foster stewardship behaviour in their students by incorporating the branches of Environmental Inquiry into their practice. The experience of teachers engaged in Environmental Inquiry (See Table 14 and the teachers' stories in Part 2 of this resource) suggests that the development of stewardship behaviour in students is more likely to emerge when one or more of the following three learning conditions are present:

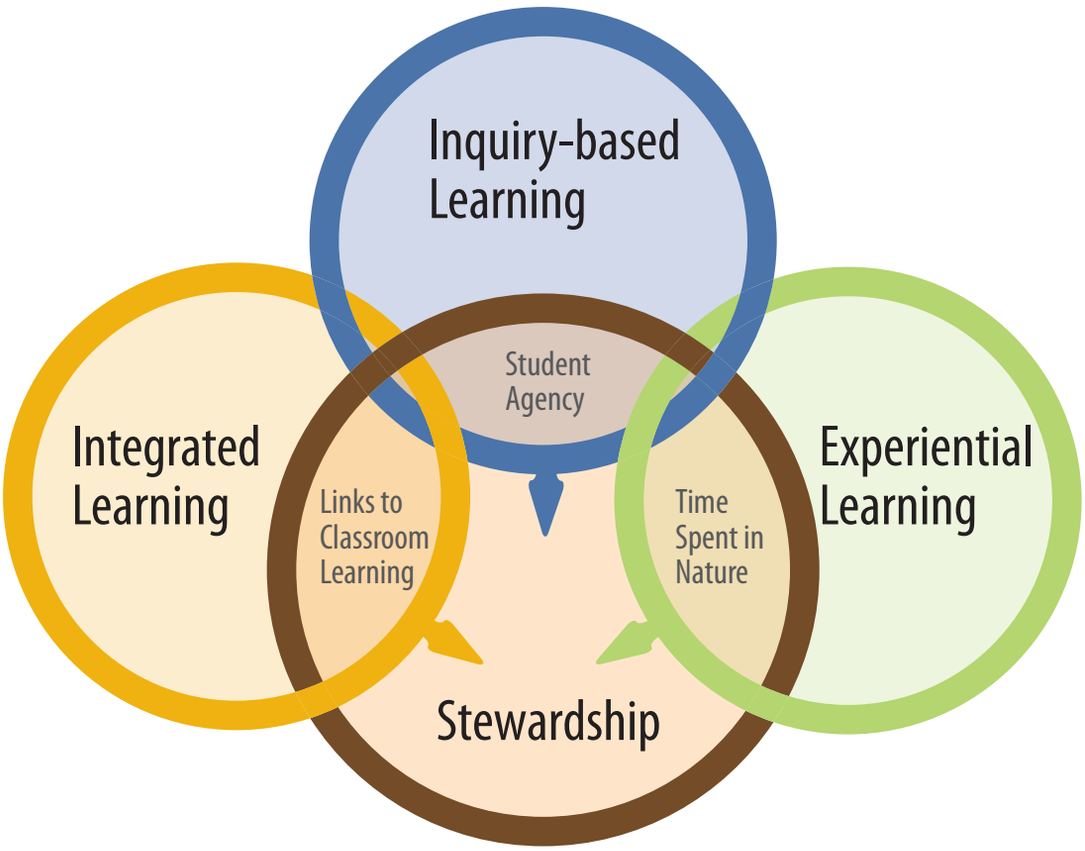
1. **Students have agency over their learning process.**
2. **Students spend time in natural settings.**
3. **Students' stewardship actions are linked to their classroom learning.**

Table 14: Classroom Examples of Learning Conditions that Support Stewardship

Learning Conditions that Support Stewardship	Classroom Examples
Student agency	• Carol's Story, SK, p. 68 • Amanda's Story, SK, pp. 122-123 • Robin's Story, Grade 3, p. 86 • Vessna's Story, Grade 4, pp. 111-112 • Ben's Story, Grade 5/6, pp. 95-98
Time spent in natural settings	• Carol's Story, SK, p. 66-67 • Amanda's Story, JK/SK, pp. 119-120
Stewardship actions linked to classroom learning	• Amanda's Story, SK, p. 126-127 • Cindy's Story, Grade 2, p. 82 • Robin's Story, Grade 3, p. 87 • Vessna's Story, Grade 4, pp. 117-118 • Ben's Story, Grade 5/6, p. 102

An interesting parallel can be drawn between the learning conditions that support Stewardship and the process of Environmental Inquiry as a whole. Upon a closer examination, each of these conditions represents an essential component within three of the main Environmental Inquiry branches, as shown in Figure 11.

Figure 11: Learning Conditions that Support Stewardship: Links to Environmental Inquiry



1. Student Agency: Stewardship and Inquiry-based Learning

Students feel empowered when they make their own decisions and are able to act upon them. In Inquiry-based Learning, students' questions and ideas are at the centre of their learning, leading the students to believe that what they think and do actually does matter. As a result, students are more motivated to participate in, or even initiate, acts of stewardship, environmental or otherwise.

> *"I wanted students to leave my classes not just better informed, but more prepared to relinquish the safety of silence, more prepared to speak up, to act against injustice whenever they saw it."*
> – Howard Zinn, *You Can't Be Neutral on a Moving Train: A Personal History of Our Times* (1994)

A primary goal of Environmental Education is to create "discerning, active citizens" who make sustainable life choices by critically questioning how human actions affect the balance of the world's social, economic, and natural systems. To achieve this goal, we as teachers need to create a learning environment (beginning in the very early school years) that encourages students to question the conditions of the world around them. The ability to ask good questions is a necessary prerequisite for the current and future stewards of this planet because it is the first step in leading students to:

- identify problems of understanding in different contexts: local and global
- exercise critical thinking and problem-solving strategies
- work toward achieving balanced solutions

In a data-driven system, however, 'question asking' tends to be the prerogative of the teacher who, in an effort to cover the required curricula, determines every step of the learning process. Students learn the content of the curriculum and accept that life within the classroom, the school, and the world at large has already been decided for them.

This kind of passive learning can be disempowering for students. When young learners come to realize that the classroom environment is not conducive to pursuing their own questions or ideas, they may assume that they are unable to make meaningful contributions within that context, let alone in the larger scheme of environmental or social issues.

David Orr (2004) warns of the larger implications of such a scenario: "We were not taught to question the physical, biological, and psychological reordering of the world taking place all around us. Nor were we enabled to see it for what it was . . . The orchard beside our house was drenched with pesticides every spring and summer, and we never objected" (p. 158).

Students develop a sense of agency when they have the opportunity to make decisions about aspects of their own learning. As a result, they feel more motivated to acquire new knowledge and may even gain the confidence to act upon it by challenging established norms and effecting change within their own community.

> *"Knowledge plus motivation equals action."*
> – David Suzuki, *David Suzuki's Green Guide* (2008)

2. Time Spent in Nature: Stewardship and Experiential Learning

The chapter on Experiential Learning in this resource summarizes some of the learning benefits associated with connecting students to the natural outdoors. There are other benefits as well. While more research is needed, there is evidence to suggest that childhood experiences in nature are connected to environmentally-conscious behaviour later in life.

Various studies cited in *Children and Nature 2009* (Charles et al., 2009) attest to this connection. For instance, one study found that spending time outdoors with at least one caring adult is a contributing factor in one's inclination for environmental stewardship in adulthood (Chawla 2006). Another study found that daily childhood experiences in natural habitats were the most frequently reported influences leading to activist behaviour in adult life (Tanner, 1978).

Similarly, a third study found that stewardship behaviour in adulthood is linked more to positive childhood memories of outdoor environmental experiences than to early acquisition of content knowledge about environmental issues (Finger, 1993, as cited in Sobel, 2008).

Building a positive relationship with nature: A foundation for stewardship

Yet, "children need to develop a relationship with nature before they can be expected to heal its wounds . . . Without that deep, abiding sense of comfort in and love for the natural world, no amount of chastising about turning off the lights or biking to school is going to make a bit of difference" (Sobel, 2008, p. 148).

Children develop this type of relationship by having opportunities to explore and wander about the natural environment, unhampered by expectations of what they must know or learn. These initial experiences need to be positive and fun. Children's sense of comfort in and love for the natural world is comparable to the bonds of trust and affection that characterize close human relationships, such as between a parent and a child, and the attendant desire to protect the loved one from harm.

Ideally, the foundation for environmental stewardship is laid during the early childhood years, where the focus is on providing positive experiences of the natural world. Exposure to serious issues such as climate change are deliberately withheld until children reach a more developmentally appropriate age (late Junior Grades and beyond). By then, students are more able to examine and process this type of information and to explore ways to make a difference as stewards of the environment. However, students at this age will still require opportunities to re-establish and/or initiate (depending on their previous experience) their emotional connection to the natural world.

3. Links to Classroom Learning: Stewardship and Integrated Learning

The chapter on Integrated Learning in this resource suggests that teachers should strive to make their students' learning holistic so that they may come to understand that everything in the world is connected and in a constant state of interaction. This is precisely why teachers of Environmental Inquiry integrate stewardship activities into classroom learning. They recognize that students' ability to internalize environmentally and socially responsible decision-making is equally as important as their ability to internalize math facts and decoding strategies.

Moreover, integrating stewardship into classroom learning contexts is vitally important because it affirms that:

- Stewardship is a fundamental part of everyone's learning, not only of those involved in extracurricular clubs.
- Stewardship is a form of civic responsibility and of comparable value to other primary learning expectations such as the acquisition of content knowledge.
- Stewardship contributes to sustainable development in real life contexts that provide for student learning.

2. Putting It Into Practice

1. How Can Teachers Foster a Sense of Agency in Their Students?

Teachers can foster students' sense of agency as stewards of the environment by providing the following scaffolds:

- "Now that we have all of this information, what do you think we should do with it?"
- "Do you think anyone else should know about this? Who?"

- "What do you think we can do as a class to help?"

Example: The Grade 4s tackle waste management

Vessna Romero, Grade 4 teacher at Victoria Village Public School, followed up on a question that evolved from a Knowledge Building Circle: How much garbage does our whole school send to the landfill? The Grade 4 class wanted to know whether the students and teachers at their school were making environmentally conscious and responsible decisions about the waste they were producing on a daily basis. The class carried out a school-wide waste audit that revealed an alarming amount of waste. In response, the Grade 4s challenged each class at their school to think of strategies to reduce the amount of waste in their classrooms and launched a Garbage Reduction Contest in the weeks leading up to Earth Day (See Vessna's Story, pages 117-118).

2. How Can Teachers Structure Outdoor Time for Their Students?

Outdoor experiences in nature can be highly structured or open-ended, depending on the specific context and intended purpose. For instance, building a school garden is a considerable undertaking that typically requires specific materials and a series of tasks. Although an open-ended experience in nature is often less structured, it does serve a learning purpose when it is organized around one or more open-ended questions that feed directly into the topic of Environmental Inquiry, but provides enough 'space' for students to explore their interests.

Example 1: The Grade 1s explore seasonal changes

To explore the broad topic of cycles with her Grade 1 students, Zoe Donoahue reserved a full morning, each season of the school year, for the children to observe the seasonal changes of a nearby urban ravine. Zoe guided the students' explorations with the following open-ended questions:

- "What signs of the season do you see, hear, feel, or smell?"
- "How can you tell that it is fall, winter, spring, or summer?"
- "What has changed since the last time we came to the ravine?"

Students ran to her with evidence – a large pinecone, a crimson leaf, an icicle. Likewise, she rushed about with her camera, snapping shots of whatever interested them, such as the frozen stream, which, as the students pointed out, flowed freely only a few months earlier. The children trudged through mud in their rubber boots, made snow angels and, using sticks, tried to crack through the frozen stream to see just how frozen it was. They ran through tall grasses and cattails whose height exceeded their own. They rested for a while, sketching observations in their Lab Books, all in an urban ravine just a short subway ride from their school.

3. How Can Teachers Link Stewardship to Classroom Learning?

In many schools, student engagement in environmental stewardship occurs within the context of extracurricular activities. Typically, student representatives from each grade level meet during recess time to discuss greening initiatives around the school and in the community. Environmental Clubs are excellent forums for empowering students, providing them with opportunities to exercise leadership in their school and to model conservation behaviour to other students.

While such approaches are certainly commendable, they can be enriched and experienced by more students through teacher efforts to integrate stewardship into the curriculum. The ensuing examples describe various strategies that teachers have used to integrate stewardship into their students' classroom learning.

Example: The Grade 4s and 5s build a School garden

Kathleen Quan, Grade 4/5 teacher at Rose Avenue Public School, wanted her students' experience of stewardship to grow from their previous inquiries into human health and nutrition, and energy conservation. With the assistance of the non-profit organization Green Thumbs Growing Kids, the Grade 4s and 5s took a leadership role in building an edible garden for their entire school community, located in one of the most densely populated neighbourhoods in Canada (See pages 140-146).

By participating in the design, building and planting of the garden, the students were able to perceive themselves as producers, rather than just consumers, while creating a hub for community engagement, interaction, and ownership. They engaged in Knowledge Building Discourse about the larger purpose behind their efforts, exploring the social, health, and environmental benefits of local gardening.

Photo 13: Grade 4/5 Students Prepare the School Garden

Example: The Grade 2s raise money for a water well

Norah L'Espérance's Grade 2s had many questions during their Environmental Inquiry into water, in particular: "Does everyone have drinkable water?" While investigating this question one child learned about an organization called the Ryan's Well Foundation, a Canadian registered charity established in 2001 to help bring safe water and improved sanitation services to people in developing countries (www.ryanswell.ca).

Inspired by the commitment of the organization's founder, Ryan Hreljac, who at age seven raised enough money to build a well for a Ugandan community, the Grade 2s organized and carried out a fundraiser of their own in support of the Ryan's Well Foundation. They made lemonade popsicles with the help of some volunteer parents, and sold them at recess.

Photo 14: Grade 2 Students Raise Funds for the Ryan's Well Foundation

Part 2

Environmental Inquiry in Action: The Teachers' Stories

> *"Teachers constantly adjust their models to fit their students and the changing realities of education. Through such constant and creative adjustment, teachers and students engage in a symbiotic relationship and form feedback loops around what is being learned. In this way, teachers are always creating their stories even as they are telling them."*
> – Gregory Cajete, *Look to the Mountain: An Ecology of Indigenous Education* (1994)

Introduction

This half of the resource is devoted to teachers' stories. These narratives describe the classroom experiences of teachers at The Lab School and at four public schools who have implemented Environmental Inquiry with their students: Victoria Village Public School, The Grove Community School, Rose Avenue Public School, and Our Lady of Fatima Catholic Elementary School.

Informative and compelling, these stories provide a view of what actually took place in these teachers' classrooms throughout the school year. These practical examples are presented in narrative form for many reasons, but largely because they place Environmental Inquiry, the reality of how it unfolds, in the context of teachers' lived experience. But more importantly, they provide a window into each teacher's thinking processes and concerns as they interpreted and applied the process of Environmental Inquiry to their respective practice. For this reason, the process looks slightly different from one teacher to the other and from class to class.

For teachers who want to begin Environmental Inquiry with their students, these stories serve as inspiration and reassurance, and offer practical entry points for getting started. There are no prescribed procedures or sequenced lesson plans to follow. Rather, teachers reading this resource are encouraged to consider these stories in the context of their current practices by thinking about the following questions:

- *What would this approach look like in my own classroom?*
- *How is this strategy or approach different from or the same as what I am doing now?*
- *What underlying pedagogical principle does this classroom example reveal?*
- *How can I bring my class closer to experiencing the principles revealed in these examples?*

Section One – Stories of Environmental Inquiry from The Lab School

The four stories in this section (Early, Primary, Late Primary, and Junior Years) are sequenced to reflect a developmental continuum of Environmental Inquiry in practice. They are not intended as examples of teaching mastery. Rather, these examples are offered in the spirit of ongoing professional development and idea improvement that each teacher continues to experience as he or she negotiates a "good fit" between the branches of Environmental Inquiry and the unique needs of his or her students. There is no endpoint to their learning as teachers, no ultimate mastery.

The Lab School stories illuminate the theoretical considerations described in Part 1 of this resource. They provide practical examples of how the teachers and students pursued key concepts or topics of investigation (such as Growth and Change in Plants), incorporating the four parts or branches of Environmental Inquiry: Inquiry-based Learning, Experiential Learning, Integrated Learning, and Stewardship. As well, these stories highlight how the teachers and students discovered meaningful connections between the curriculum content and students' emergent questions.

Section Two – Taking the Leap: Emerging Stories of Environmental Inquiry in Public Schools

This section contains the stories of seven public school teachers at four schools in the Greater Toronto Area who introduced Environmental Inquiry into their practice. These are stories of teachers' emergent experiences as they explored the possibilities of Inquiry in their classrooms. Importantly, these stories highlight how the shift to Environmental Inquiry is a gradual process, one that unfolds organically as teachers and students become more familiar with the approach. Like their Lab School counterparts, the public school teachers continue to refine their understanding and practice of Environmental Inquiry. They offer their stories here as evidence of success and as inspiration for others who have yet to 'make the leap'.

Key Concept: Growth and Change in Trees and Plants

Subject & Skill Areas: Science, Visual Arts, Math, Early Literacy Skills, Oral Language Development, Personal and Social Development

Focus of Inquiry: Trees, Plants, Roots

The Early Years: Carol's Story

Focus of Inquiry: Trees, Plants, Roots

Starting the Environmental Inquiry Process

Carol Stephenson is always amazed by the way nature manages to make her presence known in her Kindergarten classroom, particularly with the change of seasons. Each fall, she would discover bits of leaves and twigs scattered about the room, as if demanding pedagogical attention. Seven years ago, she used this occurrence to begin an Environmental Inquiry on the seasonal growth and change of trees. The Kindergartens enjoyed it immensely. She decided to try it again last year with her current SKs and was curious what direction the inquiry would take this time around. To her delight, the SKs pursued an entirely different path from the one Carol expected.

Tell us what you know. . . .

Carol always begins an inquiry by asking the children to tell her what they know about a particular topic. Last year, while most of the students were busy building structures or engaged in dramatic play, Carol sat with three or four children at a time and asked them: "What is a tree?" She invited them to draw a picture of a tree and describe it to her (See Photo 15). Carol scribed onto the drawings everything the children wanted to say about their trees.

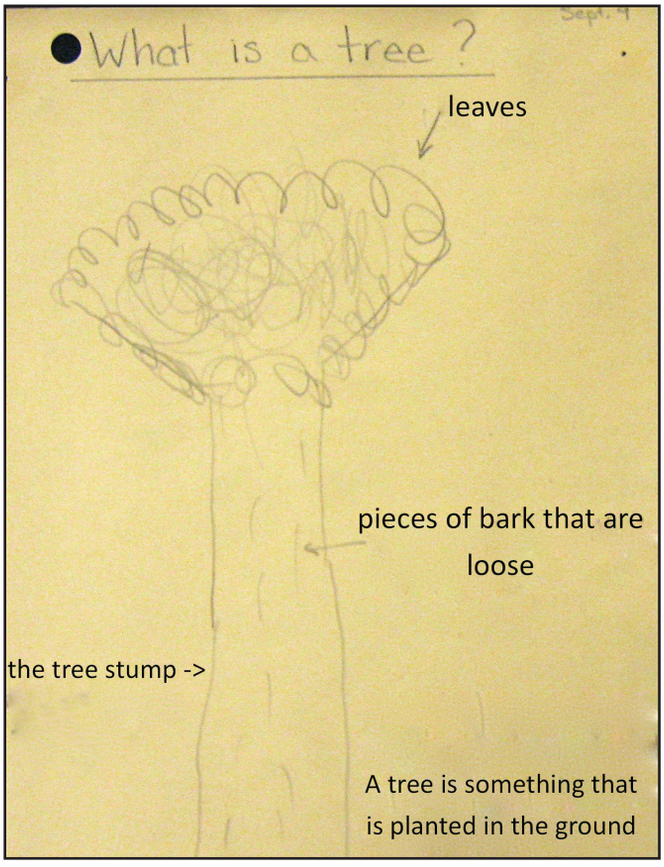


Photo 15: Initial Assessment*

* Text enhanced to ensure legibility. Original grammar has been maintained.

Carol often prompts a child's thinking by asking him or her to explain a particular part of the drawing: "I really like what you have drawn here. Can you tell me about it? Why did you decide to draw it?" She learns so much about her students from asking these simple questions and is astonished by the wealth of information they have to offer. Some of it is misinformation, but that is always a great place to start, as it helps Carol move forward in her planning.

Archiving community knowledge through Knowledge Building Discourse

Once she had accumulated all of the children's ideas, Carol gathered the SKs on the carpet for the first Knowledge Building Circle of the year. She reminded them of the purpose of coming together as a group: to give them an opportunity to revisit a question or idea that they had been thinking about on their own. "When we put all of our ideas together, it gives us an even better understanding." And so, sitting among the children in the Knowledge Building Circle, Carol asked the class: "Tell us what you know about trees".

To archive the students' ideas, Carol began drawing a tree on a large sheet of chart paper and asked the children for their input on what that tree would look like. As the children offered their ideas, a whole range of vocabulary related to trees emerged, which Carol also wrote down on the chart paper.

The children's ideas were not limited to the physical attributes of trees such as the leaves and the trunk. They also talked about animals that lived in trees or used trees in some way, and about the various ways that humans use trees. Carol wrote all of this information on the chart paper drawing. The result was a large, labelled illustration representing everything the SK class knew about trees at the beginning of the year.

Eliciting their questions

Then, as she normally does, Carol asked the children: "What are you interested in learning more about? Do you have any questions about trees, or is there anything about trees that you want to know more about?" In a culture where students are encouraged to ask questions, they inevitably have something to say. Initially, not every child will contribute, which is fine. Carol has learned from experience that "you just need to have a few questions to start you off".

SKs' initial questions about trees

"How do trees change and what does that look like?"
"How do trees grow?"
"How do roots work?"
"What do trees need?"

"It is important to explicitly ask children to share their questions. They need to know that we want to know their questions. They need to know that they can wonder out loud."
– Carol Stephenson, SK teacher

Establishing a personal connection with nature and each other

Very early on in this inquiry, Carol gave the children a homework assignment to help them think about their personal connection with trees (See Photo 16). She asked the students to work with their families to accomplish three things:

1. Identify a tree in their life that was special to them
2. Draw that tree
3. Explain why it was special

Each child was invited to share their 'tree story' with the rest of the class.

Dear SK Parents,

Today the children are bringing home their first piece of SK homework. It is about choosing a tree that is special to them in some way.

You will note that this homework calls for some writing. In SK, it is not our expectation that all the children do all of their own writing. Rather, we are hoping that this work will generate an interesting conversation at home that will help the SK children know more about themselves and the environment in which they live. Please support the writing in a manner that works best for you and your child. This may mean that you scribe all or some of your child's ideas. You are welcome to guide your child as he or she attempts phonetic spelling. You may even spell some words out for your child to write.

We hope your family enjoys this homework and other activities that will be sent home as they come up.

Photo 16: Homework Letter to SK Parents

This homework assignment served a number of purposes. It motivated the children to learn more about trees by prompting them to think carefully about their personal relationship to this part of nature. It was also a way for Carol and the students to get to know each other and build a learning community through their shared experience of having a 'special tree'.

> *"Story is a way to root perspective. . . True learning occurs through participation and honouring relationships in both the human and natural communities."*
> – Gregory Cajete, *Look to the Mountain: An Ecology of Indigenous Education* (1994)

This homework task was also carefully designed to both welcome and value the diverse group of learners in Carol's class. Carol did not have an agenda about right or wrong answers. She deliberately left the homework questions open-ended to allow the children to venture in different directions and to enable each child to contribute their unique experience in their own way.

The SK students enjoyed sharing their stories and drawings, and spoke freely and naturally about their lives. It seemed that in no time, they knew so much about each other's thoughts, experiences, and relationships. Moreover, their drawings and stories revealed to Carol how each of her students had come to know and understand trees.

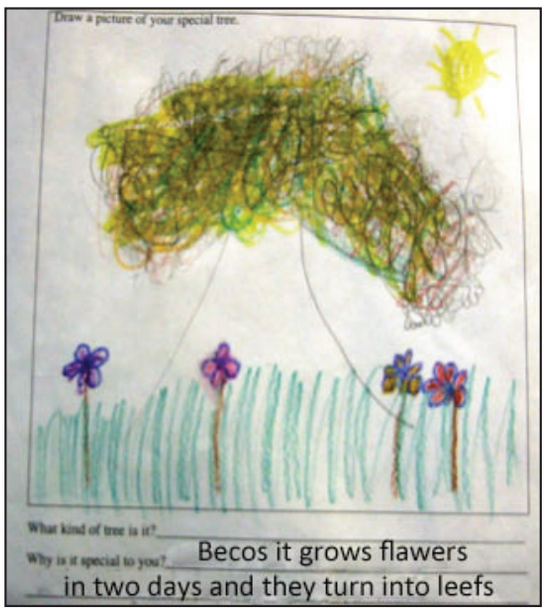


Photo 17: SK Homework Sample 1*
* Text enhanced to ensure legibility. Original grammar has been maintained.

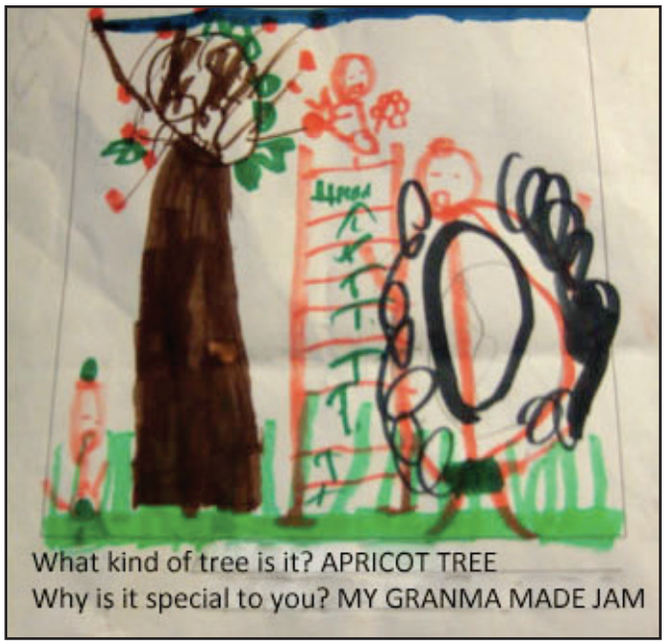


Photo 18: SK Homework Sample 2*
* Text enhanced to ensure legibility. Original grammar has been maintained.

Exploring new directions – understanding tree roots

An essential aspect of the inquiry process is about encouraging children to express their theories and put forth new ideas and questions. This can be done through drawing, building, writing, and oral expression. Knowledge Building is often an ideal context for venturing into children's emergent ideas and interests. Regardless, it is the students' questions that provide the impetus for an inquiry, as was the case during one KB Circle, in which Carol was interested to hear children's ideas about the question: "How do trees grow?"

Carol returned to this question, by saying to the children, "I don't know how trees grow. What do you think?" Interestingly, this group of students did not launch into a discussion about the upward growth of the trunk and branches of a tree, as was the case seven years ago with a different class. Rather, this group was interested in exploring the growth and changes that occur underground: roots!

Although the students were clearly interested in the subject of roots, their comments and theories about their structure and appearance revealed several misconceptions. They were unsure if roots were connected to anything, and did not understand where they went or what they looked like. Carol used this problem of understanding to inform the direction that she took the Environmental

Inquiry about growth and change in trees and plants. The SKs started an inquiry about roots, not because Carol had planned this topic in advance, but because their questions had led them in that direction. By focusing on a key concept – growth and change in trees and plants – rather than on specific pieces of content, Carol was able to honour the children's natural curiosity about roots while meeting the intended learning goals that she had envisioned at the outset.

Experiential Learning

"How do trees change, and what does that look like?" Carol wanted her children to investigate their question through direct experience with real trees – trees that they would come to know personally by visiting them regularly throughout the year. In early September, she and the class walked to Sibelius Park (located in the neighbourhood) to look at trees. The students began their investigation by looking at the trees' various shapes, sizes and colours, and enhanced their sensory appreciation by also touching and smelling them. Each child chose a favourite tree and took two photographs of it: one from far away and one at close range. Back in the classroom, the children examined

Photo 19: An SK student's pastel illustration

Box 1:
Knowledge Building Circle:
"How do seeds come alive?"

Student 1: How do seeds come alive?
Student 2: Sun and water helps it come alive.
Student 3: The wind makes the dirt kind of flow and then the dirt forms a seed.
Student 4: The sun helps the seed like grow into a flower or stuff that you can eat and then the sun helps soil get into the seed so it grows a little bigger.
Student 5: The sun dries up the dirt and then the soil gathers into the dirt and makes it into a seed.
Student 6: If we plant apple seeds, will they grow?
Student 4: I think they will grow into apple trees.
Student 3: We were going to plant oranges but we lost the seeds.
Student 7: They've already been used so they'll work again.
Student 2: Once we plant those seeds we'll have a juicy tree.
Student 8: We'll need some earth to plant them in, to bury them.
Student 9: We need a pot.
Student 2: In dirt.
Student 3: From a flower store.
Student 4: Or get it from the ground.
Student 10: You can dig a hole in the woodchips (in the school's playground) because there's dirt under there.

their photographs carefully and used art pastels to illustrate the interesting features of their special trees – while also demonstrating to Carol their remarkable observation skills and attention to detail (See Photo 19).

The SKs noticed a number of interesting changes when they visited Sibelious Park for the second time that fall:

- "My tree looked bended."
- "A lot of leaves fell off."
- "My tree looked the same."
- "Lots of leaves turned colour and fell off."
- "It had no leaves on it."
- "A few leaves fell off it and it changed colour."
- "My leaves had all fallen off and were all brown."

They revisited Sibelius Park a number of times throughout the year to observe their trees' seasonal changes.

By connecting learning opportunities to places in the community, children come to believe that learning is possible beyond the confines of the classroom. Frequent visits to special places can help them connect with the natural world in tangible ways, while also fostering their sense of place within the community and in nature.

Designing experiments about roots

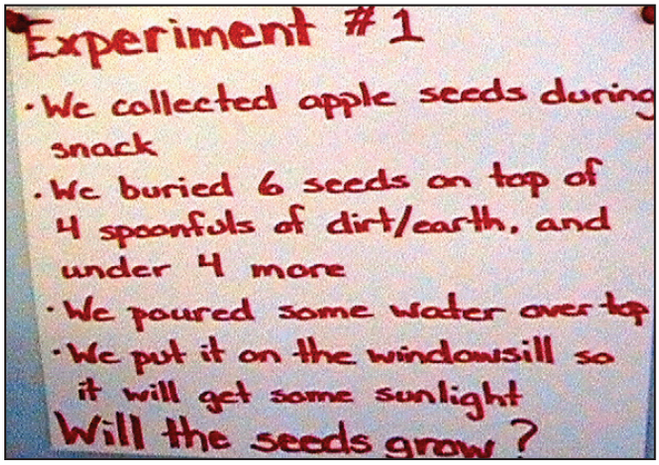
The SKs wanted to understand how their trees' root systems worked, but digging up a tree was obviously not an option! Carol turned their attention to various plants in the classroom, as a means of extrapolating information about tree roots. The students designed experiments using a variety of plant forms (including a vine cut from another plant, carrots, and bean seeds) and planting methods (planting some things in soil and others in water) so they could clearly see what roots look like as they grow.

Throughout this process, they tried to imagine how some of their plants might change and from where the roots might grow. They used magnifying glasses to examine different parts of their plants before sketching their observations, and they predicted what might happen to their plants, and why.

Carol scribed the children's predictions. She knew that she would not receive the full measure of their understanding if she expected them to do all the writing; the mechanics of writing at this young age would demand from them considerable energy and effort.

Wherever possible and appropriate, Carol finds opportunities for her students to contribute to the design of class experiments. By relinquishing some of her control in this area, she empowers her students – as active participants instead of passive observers – in the thinking and problem-solving process.

To illustrate this point: A child had asked Carol if the SKs could plant some seeds from his apple, to see if they would grow. Carol seized this opportunity for the children to design an experiment. She asked this child to share his idea with the whole class during a Knowledge Building Circle about the question: "How do seeds come alive?" This type of experiment was easy to follow up and well worth the benefit of having the children feel that their ideas were valued.



Most often the design of kindergarten and early primary experiments at The Lab School involves the input of both the teacher and the students. Regardless of who designs the experiment, Carol asks her students questions throughout the process (See Table 15) to help them think more explicitly about what is happening in their experiment.

Table 15: Examples of Prompts for Students' Reflection*

Before the Experiment	During the Experiment	During and After the Experiment
"What do you think is going to happen?" "Why do you think that is going to happen?"	"What do you see happening?" "Look closely. Has anything changed?" "Is everything the same?"	"Why do you think that happened?" "Did you expect that to happen?" "How is what you saw different from what you thought would happen?" "What does this mean about _____?"

*At all of three experimental stages, children's responses to these questions can take any form of expression including speaking, dramatizing, writing, and/or drawing.

The manner in which the children predicted, observed and reflected on the growth of different plants revealed to Carol many of their ideas and thoughts (See Photo 21). As one child exclaimed about her bean growing experiment: "It's almost like they're eating the seeds!" She had noticed that the bean seeds were splitting apart and looked like they were being subsumed into the stalk.

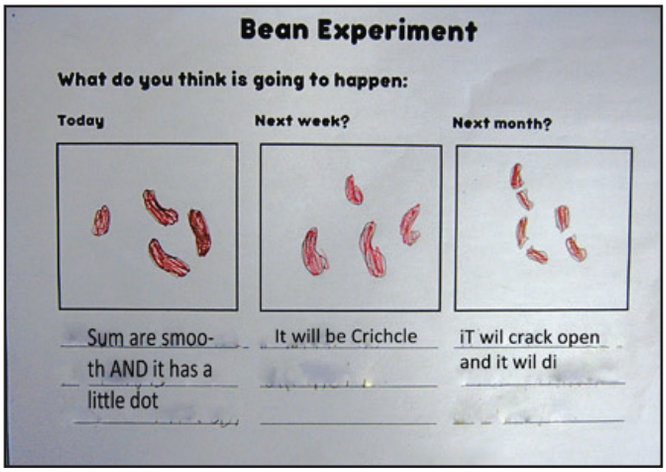


Photo 21: The Bean Experiment*
* Text enhanced to ensure legibility. Original grammar has been maintained.

The carrot experiment: Growth in water and growth in soil

The SKs were pleased that they were able to observe roots growing from the plants placed in water (in clear jars). They naturally assumed that carrots would grow roots in the same manner.

Therefore, Carol placed four carrot tops in a clear container filled with water. Before long, the carrots began to decompose and turn to mush. The children compared the differences between these carrots and the ones planted in soil. They illustrated these changes in their sketchbooks and explained their ideas to Carol. It seemed to the children that soil was important to the growth of plants.

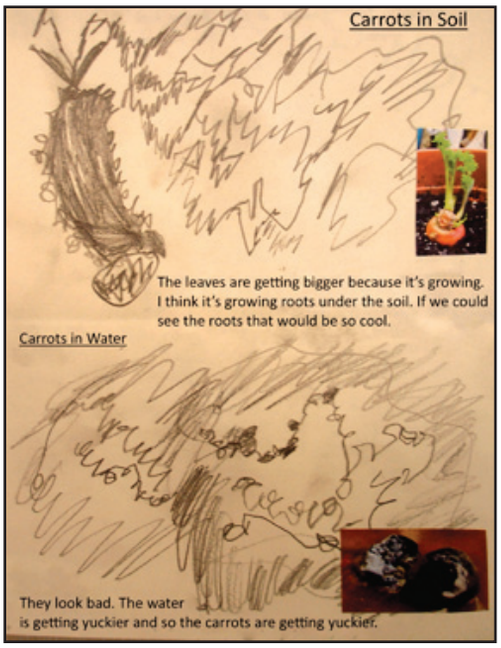


Photo 22: An SK Student's Observation and Reflection*
* Text enhanced to ensure legibility. Original grammar has been maintained.

This idea about the importance of soil took on greater meaning because of a sweet potato that Carol had brought in. The sweet potato had been sitting in water for quite some time. To the children's surprise, it had sprouted a long root! After witnessing the demise of the four carrots in water, the children concluded that the sweet potato needed to be in soil.

As the SKs gathered together in a Knowledge Building Circle to discuss their individual observations with the whole group, they collectively stumbled upon a new question: "Do roots always grow in a downward direction?" (See Box 2).

Authoritative sources and informational research

It is important for children to feel that their own observations are just as important as the information that they find in books. Carol and the SKs consulted books and other authoritative sources as part of their research and learning, but only after the students had been given the opportunity to posit their own ideas. They looked at information books together as a class, and individually explored the pictures in books on their own.

Box 2:
Knowledge Building Circle:
"Do roots always grow in a downward direction?"

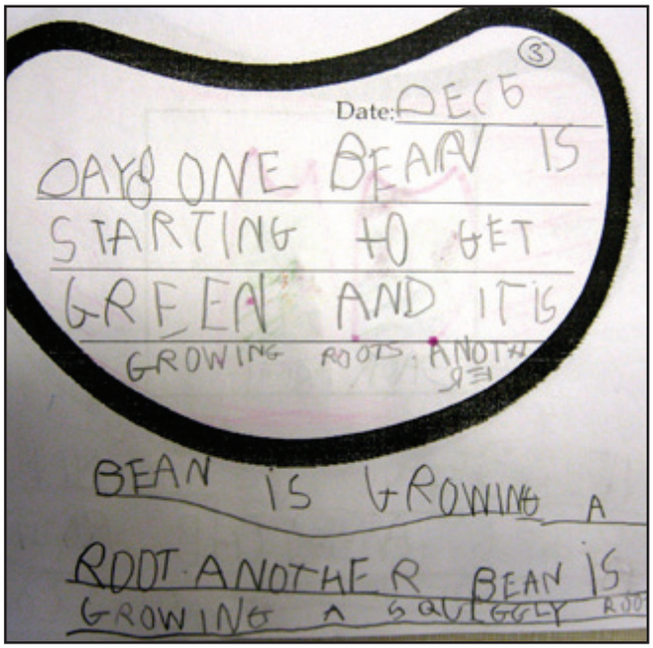
Carol: What is happening with this one [top of carrot in water]?
Student 1: Roots!
Carol: Where are they coming from?
Students in unison: The sides!
Carol: The sides! Did you expect the roots to be coming from the sides?
Multiple students: No.
Carol: No? If you said no, could you put up your hand so I can see you? Where did you think the roots were going to come from?
Student 2: The bottom.
Carol: Why did you think they were going to come from the bottom?
Student 2: Because that's what it usually does.
Student 3: I think that the roots were going to come from the bottom because all plants' roots usually come from the bottom.
Carol: I have always thought that myself, that roots come from the bottom. But what are we seeing with the plants that are growing over there? Let's look at what's happening with this one [plant that is placed in water].
Student 4: Roots coming from the sides!
Carol: Is that what we were expecting to happen?
Multiple students: No!
Carol: Many of us were very surprised when little, little white dangly bits started coming from the side. And are they little now?
Multiple students: No!
Carol: In fact, what is happening every time we look at them?
Multiple Students: They're getting bigger!
Carol: They are just getting bigger and bigger! Now, what else happened to some of the carrots?
Student 6: They were smushed up!
Carol: Look at it now. I think you can see it from where you are.
Multiple Students: Ew!
Student 7: It's even badder!
Carol: What is happening to it? Were all the carrots like that?
Student 7: That one survived!
Carol: Where is another survivor?
Student 8: [pointing to the carrot planted in soil] In there! It grew!
Carol: How do you know?
Student 9: The green leaves is getting higher and higher and higher.

Integrated Learning

Language: Print awareness, letter-sound correspondence, and encoding

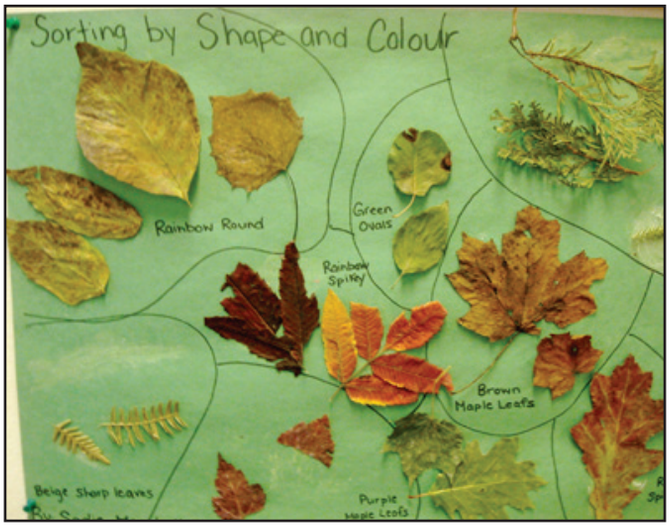
While Carol does scribe many of the children's ideas, there are times when she asks the children to do their own writing, and when the children themselves express their desire to write. The combination of Carol's scribing and the students' own writing provides a wealth of information about the children's ideas and early literacy skills in encoding and letter-sound correspondence, sight words, content-related vocabulary and letter formation.

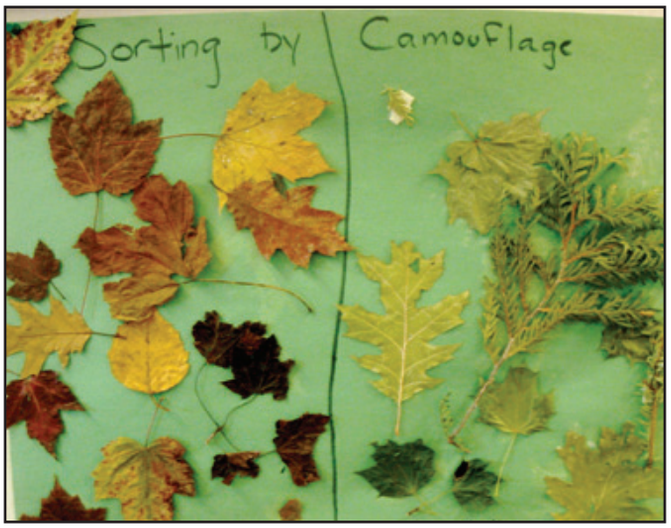
Each child had a "Bean Book" in which he or she described, in words, their observations of the beans as they changed and grew. As well, the children wrote descriptions to accompany the sketches of their experiments. The SK children were highly engaged in this writing task because it was inspired by questions and direct experiences that they cared about.



Math

As was the case seven years earlier, leaves of different shapes, sizes and colours somehow ended up scattered about the classroom, particularly after a class visit to Sibelius Park, when the children brought back their collection of various types of leaves. Carol saw this as an opportunity to explore early concepts of geometry and data management. With their batches of leaves, the children worked in small groups to discover interesting ways of sorting, using attributes such as *camouflage*, *colour*, *size*, *and shape*.





Visual arts

The ability to observe the details of an object is an invaluable skill. Children deepen their observation skills through hands-on art activities. Those who do not yet have the verbal skills (oral or written) to express what they are able to observe, may know a great deal more about a particular topic than is readily apparent. Often they are able to communicate that knowledge visually by drawing or sculpting 'what they know' in clay or plasticene. For this reason, Carol often deconstructs a child's artwork by decoding its visual elements, labelling its features and transcribing what the child says in order to understand more fully what that child understands.

Toward the end of an inquiry, Carol also provides the children with an opportunity to revisit the inquiry question through visual art. She compares the child's current artwork with their initial representation. Typically, these before-and-after comparisons are striking because they reveal how that child's thinking and knowledge have improved over time. A child's drawing created at the end of an inquiry contains much more detail compared to his or her drawing made at the beginning of the inquiry, because the child has acquired considerably more knowledge to bring to the illustration. The child's idea improvement about "What is a tree?" (See Photo 25) affirms the power of visual art as a form of self expression and communication.

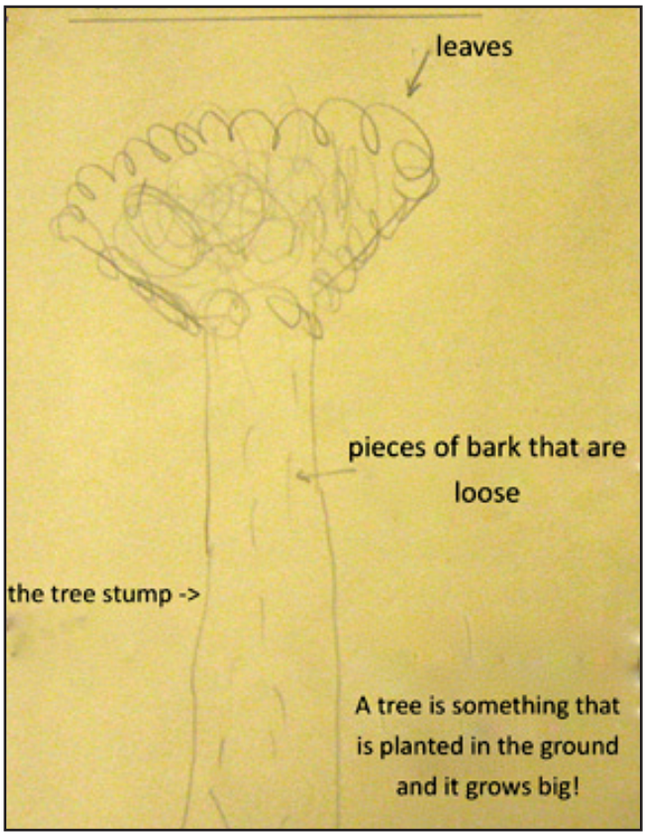


Photo 24: Initial Understanding*
* Text enhanced to ensure legibility. Original grammar has been maintained.

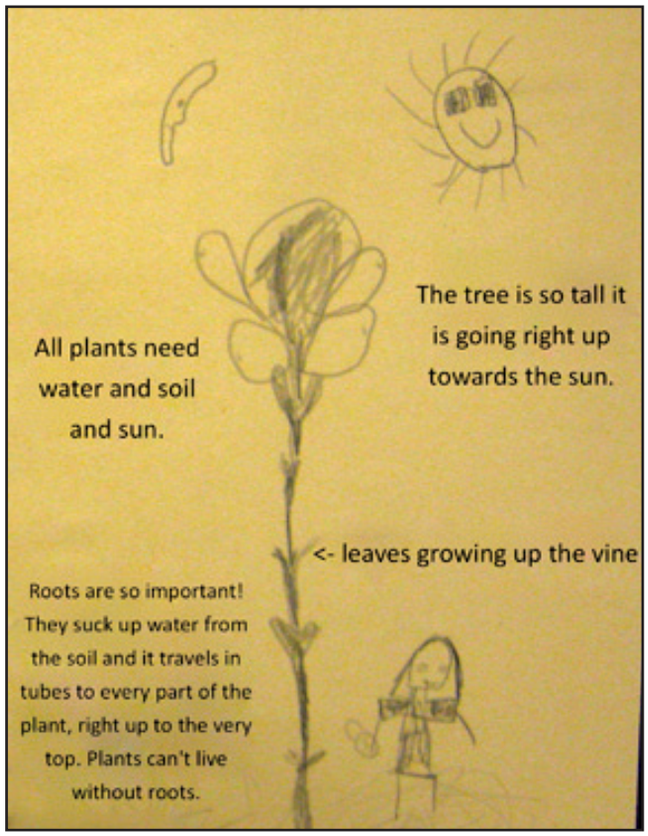


Photo 25: Evidence of Growth*
* Text enhanced to ensure legibility. Original grammar has been maintained.

The initial drawing on the left lacks the level of detail of the second drawing on the right. In Photo 24, the child has created a swirl of indistinguishable leaves at the top of her tree. In the Photo 25, she has drawn individual leaves, each with a specific shape, whose growth extends beyond the top of the tree.

The first drawing depicts a tree in isolation. However, the second drawing conveys this child's understanding of the many connections between trees and other parts of the natural world. She has drawn a sun in recognition that plants need sun to grow, as well as to show her new understanding about why trees grow so tall and in an upward direction. She includes roots in her second drawing, along with a detailed explanation of their function and importance (scribed by Carol). And what better demonstration of this child's sense of place than the inclusion of herself in this drawing?

This simple drawing exercise is also an example of embedded assessment. Carol often posts these kinds of drawings side-by-side on the classroom wall to enable the children and their parents to see the growth of their understanding.

Stewardship

With the arrival of spring, Sibelius Park was becoming green once again. The SK children returned to their familiar place to celebrate Earth Week and their learning about trees and plants. With plastic gloves and garbage bags in hand, each SK child paired off with a Grade 5/6 student to make sure that the place they had come to love was litter-free. They completed their celebration by drawing pictures of the park's environment.

This form of stewardship made perfect sense for the SKs. It was a way to reach out to the community and it was connected to what they were learning. For the SKs, the experience of learning about trees in an observable and tangible setting, affirmed the notion that Environmental Education happens "here" in their local community, not "somewhere out there".

Key Concepts: Growth and Change in Plants and Animals, Habitat, Interconnectedness, Characteristics of Plants and Animals

Subject & Skill Areas: Science, Language Arts, Art, Math, Research, Oral Communication

Focus of Inquiries: Trees and Forests, North Atlantic Salmon

The Primary Years: Cindy's Story

Focus of Inquiry: Trees and Forests

Starting the Environmental Inquiry Process

Grade 2 teacher Cindy Halewood wanted to introduce the concept of Growth and Change to her students by providing opportunities for them to directly observe and experience naturally occurring phenomena. The study of trees and forests was an obvious choice. What could be more observable than these compelling markers of seasonal transformation? To bring her students in direct contact with a variety of trees, Cindy decided to bring her class to a nearby urban forest located behind the old kiln factories of Toronto's Don Valley Brick Works, nestled within the watershed and floodplain of the Don River

Less than six days into the school year, Cindy began preparations for this excursion. To get the students thinking and wondering about trees and the changes they experience, she read aloud *The First Red Maple Leaf* by Ludmila Zeman, a story told in the folklore tradition, which features the dramatic seasonal changes experienced by trees.

The students then sat on the carpet for their first Knowledge Building Circle of the year. Cindy asked them to think about the story, about what they had already noticed about the trees just outside their own door, and about what they might see on their upcoming excursion. She wrote the title "I Wonder…" at the top of a large sheet of chart paper and asked children to share their questions about trees and forests (See Photo 26).

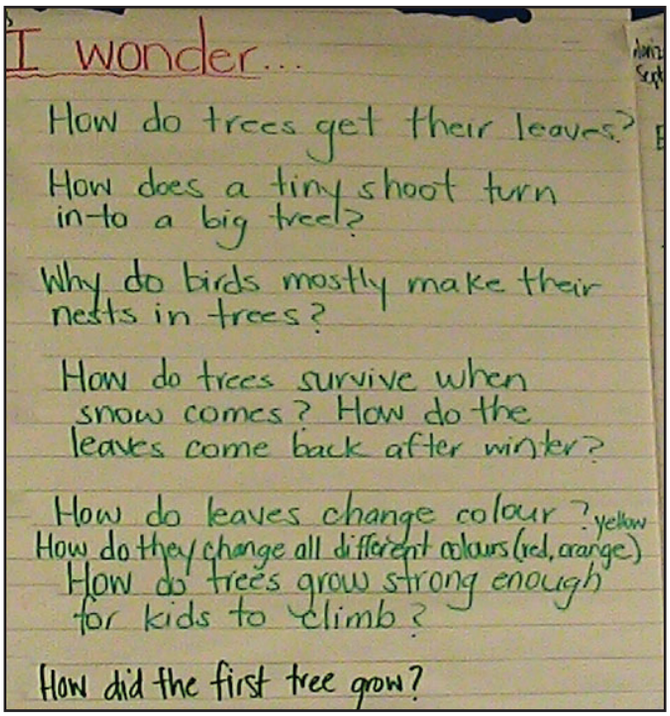


Photo 26: Students' Tree Questions

Once the children had shared their initial questions, they began to share initial ideas in response to some of the questions, such as: "Why do leaves change colour?" (See Photo 27).

Cindy posted the children's questions and explanations on the wall, where they remained until the end of the year. This served as a powerful testimony that the children's thinking was, and continued to be, a highly valued part of the learning process. It provided an ongoing frame of reference and an assessment tool for both the students and the teacher. It enabled them 'to see their learning' by looking at their initial ideas and how they improved and developed throughout the year. In addition, it provided opportunities for children to make connections between earlier and subsequent topics of study.

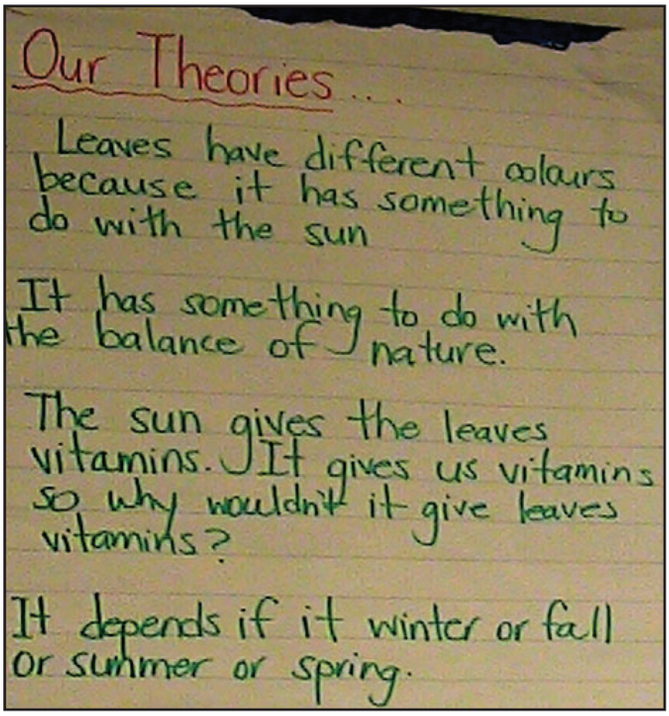


Photo 27: Why Do Leaves Change Colour?

Experiential Learning

The urban forest excursion

Cindy wanted the urban forest excursion to be an enjoyable experience for the children, one that would help them feel more connected to the natural world and, in doing so, would foster their sense of stewardship. She gave the children one basic, but important, instruction: "Notice".

The children were excited as they ventured into the forest, each carrying a clipboard with two sheets of paper on which to record their observations. Cindy asked the children to each select a tree that appealed to them in some way and, using the

Photo 28: Anatomy of an Interesting Tree

first observation sheet, to sketch and label four parts of 'their tree' (See Photo 28). The goal of this exercise was to practice the skills of observation and documentation, an important skill set used in scientific research.

The second sheet was more open-ended than the first. Its purpose was to draw students' attention to the bigger picture: To put that individual tree in the context of the larger ecosystem in which it existed. Cindy asked the students to record their findings

on this second sheet – to list all of the different things, living and non-living, that they noticed. Items on the students' lists included: a pond, logs, trees, frogs, a hawk, bulrushes, flowers, dragonflies, snapping turtles, lily pads, grass, rocks, ants, wasps, minnows, and snails.

The excursion altered the children's earlier understanding about forests. They came to view the forest, any forest, as more than a clustering of trees but rather, an ecosystem abundant with life – animal and plant, large and small, seen and unseen. The students built on this understanding by gathering information about trees and forests from the almost 150 books that Cindy had collected from the school library, various public libraries, and Value Village. They asked questions that were increasingly more complex. For example, a Knowledge Building Circle held later in the year led to the question: "What would be important to include in a healthy forest? What is an ideal forest?"

The students posed a number of theories including:

- "At the bottom of the waterfall, lily pads, frogs, ducks, and water birds. Frogs and stuff would probably like to live there. There's a lot of froggies in forests."
- Vines and tall trees. Big leaves growing out of the ground, not just up high in the trees. This might be good shelter for little animals that can't climb into the palm trees."
- "Not just green leaves but red leaves because some bugs might like to eat them."
- "Dirt with bugs and worms in it. Worms help because they make holes when they go in to the ground near roots and then when the rain falls it goes into the hole and up to the roots."
- "In a ideal forest you need trees and animals like foxes and birds and bugs and chipmunks and mice."

Using SMART Board, the students created a drawing of an ideal forest, which represented the collective knowledge and ideas of the whole class (See Photo 29). Each child had an opportunity to add or remove parts from the "ideal forest" that they thought were necessary.

Photo 29: The Grade 2 Students' Ideal Forest

Integrated Learning

The Grade 2 inquiry into trees and forests integrated various subject areas and skill sets including, drama, visual art, writing, designing/building, and research.

For example, they studied a children's version of Shakespeare's play, A Midsummer Night's Dream. Working with the art teacher, Tara Rousseau, they designed and built a 3D theatrical set out of recycled materials. The children contributed to every stage of the design process, posing questions and negotiating solutions to create a design that accurately reflected the 'true' environment (a forest in Athens, Greece) in which the play is mostly set (See Table 16).

They conducted research on trees and forests in Greece by consulting books and informational texts. They learned that forests in Greece contain two structurally different categories of trees, coniferous and deciduous, and visually

Table 16: Research and Design for A Midsummer Night's Dream

Examples of Students' Questions	Examples of Students' Ideas
What kinds of recycled materials should we use?	newspaper, papier mâché, toilet paper rolls, paper bags, cereal boxes
What should we include in our forest?	animals, fairies, trees
What kinds of trees are in a forest in Athens?	"We need to research that! We can look in books about Ancient Greece and look for pictures of trees and leaves." "Tim can ask his family."
How do we know what kinds of leaves to make?	use real leaves, draw them on paper, trace them.

incorporated this understanding into their set design. In effect, the children learned that the creative process can benefit from background research, and that some forms of artistic expression can be both creative *and* informative.

Visual art

One day, after a Knowledge Building Circle (See Box 3), the children went outside to the front of the school, charcoal chalk and sketch paper in hand, to sketch a tree of their choosing. Before setting chalk to paper, they spent the first while considering the entire structure of their chosen tree. They demonstrated their understanding of artistic elements such as shadow and perspective, incorporating them into their drawings.

Writing

The class had looked at numerous non-fiction books about trees and forests. One day, they discussed the fact that non-fiction books and informational texts, including the ones in their classroom, used certain writing devices and stylistic approaches to inform readers about various topics, such as the identification and classification of trees. The children discussed the various ways in which trees are identified and differentiated from one another. Then, modeling the writing conventions and categorization guidelines of the books they had consulted, they wrote their own informational texts on the identification and classification of trees (See Photos 30 and 31).

Box 3:
Knowledge Building Circle:
"Trees"

Cindy: [referring to a student's photo of a tree] What do you notice about how the trunk of the tree looks?

Student 1: It's really thick!

Student 2: It's thick but then it splits up into smaller branches.

Student 3: Yeah. Then it keeps on splitting into smaller and smaller branches.

Cindy: Does anyone have any theories about why trees split into branches like that?

Student 4: They need to share the weight of the snow.

Student 3: I think it's a way for the tree to make more leaves to get more sun.

Student 5: More branches means more leaves.

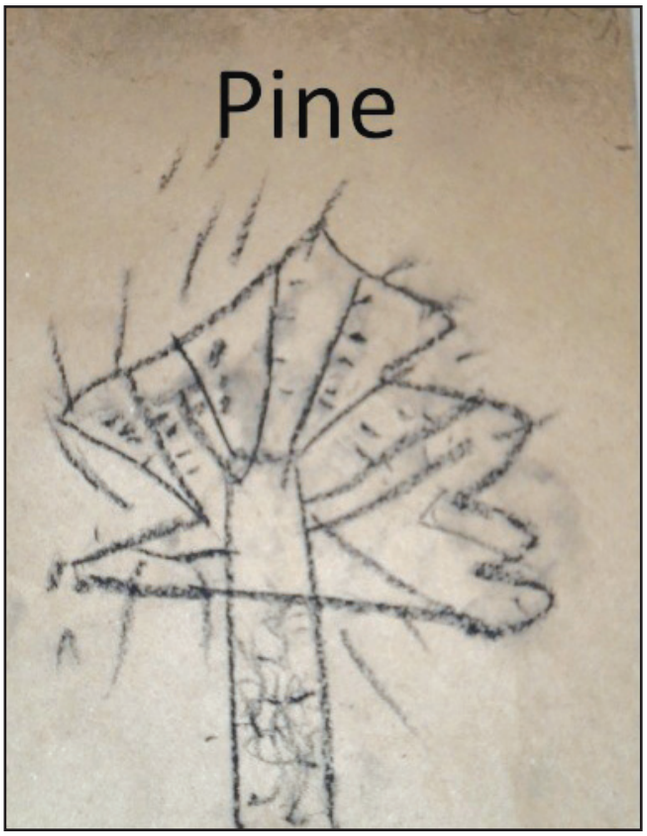


Photo 30: A Charcoal Sketch of a Pine Tree

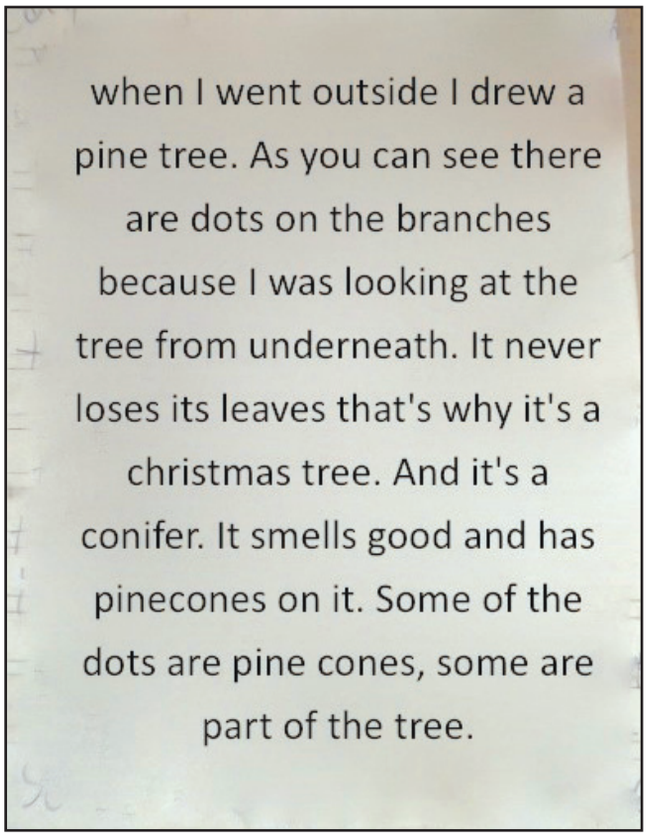


Photo 31: Informational Text About a Pine Tree?*

* Text enhanced to ensure legibility. Original grammar has been maintained.

Focus of Inquiry: North Atlantic Salmon

Starting the Environmental Inquiry Process

In January, as the Grade 2s began an inquiry into the growth and change of fauna, Cindy provided them with an opportunity to observe, in their own classroom, the real-life occurrence of a natural phenomenon: the growth of salmon eggs into salmon fry. She contacted the Ontario Federation of Anglers and Hunters' *North Atlantic Salmon Restoration Program*, which facilitates a classroom hatchery program.

The children learned at the onset that salmon eggs require a high level of care. They witnessed the mulitple steps required to set up the classroom salmon hatchery: a 30-gallon tank with a chiller to keep the water temperature at approximately 7°C.

Then a magical moment occurred. A representative of the *North Atlantic Salmon Restoration Program*, introduced 100 salmon eggs into the tank. The children were exhilarated. Like the parents of newborns, they were instantly committed to the care of their small charges.

All the while, Cindy had been taking photographs of the event that came to be known as "The Day the Salmon Came". She did so with a particular purpose in mind: to elicit the children's questions and ideas, which is precisely what happened. The students looked at the photographs time and again. They wrote their questions on long strips of chart paper, which Cindy displayed on an "I wonder" board directly above the salmon tank (See Photo 32).

A Sampling of Children's Questions on the 'Wonder Wall'

"I wonder how many salmon will hatch?"
"How many salmon are there in the world?"
"Why are salmon sometimes orange and sometimes grey?"
"What do salmon need to live?"
"Why do salmon die?"
"How do salmon find their way to the ocean and back?"
"I wonder how many will survive?"
"When will they be released?"

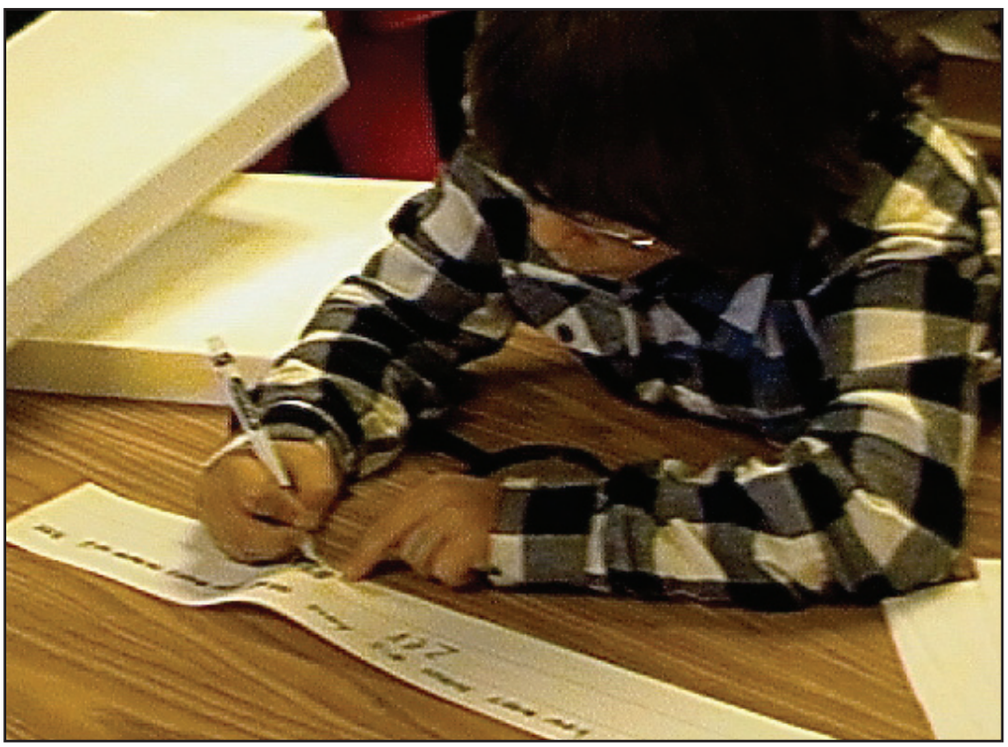


Photo 32: 'I Wonder…' Strips

Experiential Learning

The children observed the salmon eggs changing over time. Each morning, they rushed to the tank to see what might have happened since the previous day. Sometimes many days passed by with no observable changes, but even this observation led to important idea sharing and community building through KB Discourse (See Box 4).

The students documented their growing questions and theories until it became clear that they needed to compare the ideas of experts to their own. They researched authoritative sources such as picture books, information books, realistic fiction, and guest speakers. They learned about fish anatomy with the help of a Grade 2 parent who dissected a fish in the classroom.

After three months of caring for the salmon eggs, the children engaged in one of the most meaningful outdoor learning opportunities of the year: the release of the salmon fingerlings. Led by a representative from the Ontario Federation of Anglers and Hunters, the Grade 2s brought the salmon to Duffins Creek (located on the Pickering Airport Lands). There, each child had an opportunity to release a salmon fingerling into the creek.

Box 4:
Knowledge Building Circle:
Baby Salmon

Cindy: What did you notice about the salmon eggs after they hatched and Chris took them out of the condo?

Student 1: They fell into the rocks.

Student 2: Well, it's kind of boring because you can't really see them. They're not doing anything.

Cindy: What do you think they are doing? Does anyone have any theories?

Student 3: They are feeding on their yolk.

Student 4: They're hiding.

Student 5: They're hiding because baby salmon in streams and rivers do that to protect themselves from birds and rocks and bigger fish.

Student 6: That's like the book that we read the other day. . . Salmon Creek.

Cindy: What is that book about?

Student 6: A salmon who journeyed to the ocean and then came back to lay eggs in a stream and it said it was a rough journey.

Photo 33: Salmon Release Day

Integrated Learning

Habitat and math

The Grade 2s did not simply watch the salmon grow. They played an important role in raising the salmon by carefully monitoring their habitat. To do so, they needed to investigate the question: "What do salmon need to live?" Cindy used this as opportunity to integrate the students' learning about habitat with mathematics concepts such as the metric system of measurement.

The fish needed to be fed a certain amount of food each day, which the children carefully measured in millimetres before adding it to the tank. The concept of time was also integrated into this daily routine. Each student monitored and documented the precise time that he or she fed the fish. Finally, the Grade 2s also read the thermometer and recorded the temperature of the water, knowing, now, that the salmon would perish if the temperature became too warm.

Although the students were already raising 100 eggs, they wanted to do more. They organized a school-wide bake sale, which raised $452 for the *Lake Ontario North Atlantic Salmon Restoration Project*, to support a classroom hatchery program in another school. This fundraiser also provided the opportunity to integrate applied learning about money concepts including coin value and making simple change (through addition and subtraction).

"Salmon are like trees. They start out like a seed and then branch out and get bigger and bigger."
– Grade 2 student

Stewardship

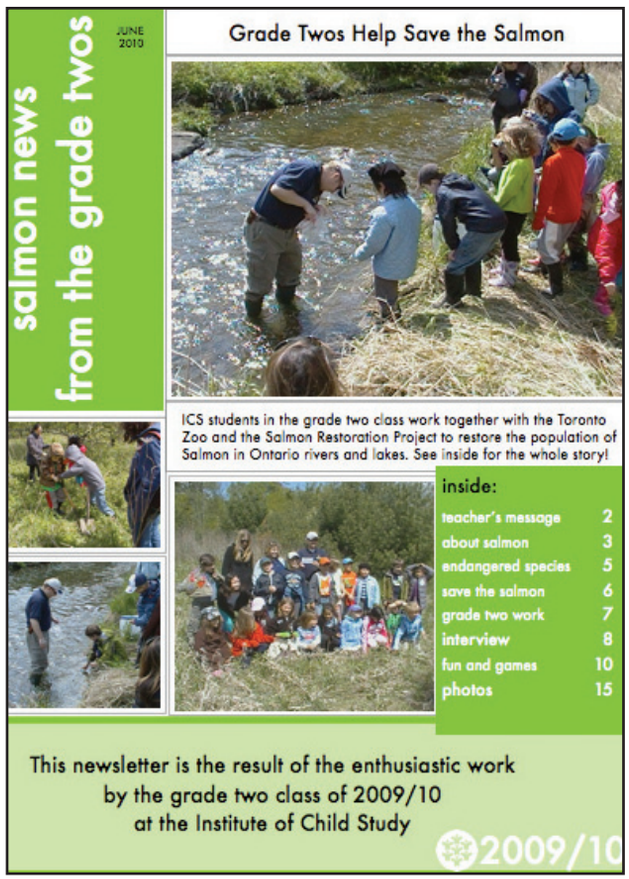
The Grade 2s made two important collective knowledge advances: The first was that salmon need a healthy water environment to grow and thrive. Another advance was that trees also play a role in the lives of salmon, providing shade which helps to cool the rivers, lakes, and streams. Then, the Grade 2s took on another project planting trees along the creek into which their salmon were released. They knew this would help to ensure the survival of the salmon.

Fostering public awareness

The children became emotionally attached to their classroom salmon, caring and worrying about their wellbeing. The developing salmon became an integral part of the Grade 2 community. The children's sense of responsibility for the salmon developed naturally as did their connection to this part of nature. Their sense of commitment was initially driven by their curiosity. This stewardship deepened as the children learned more about salmon – how they developed, their habitat requirements, their life cycle.

The students inevitably felt compelled to share with others the knowledge they had built together through the year. They chose Earth Day as an opportune time to celebrate their learning about salmon and to share it with others. They did this by choosing various facts about salmon and their habitat that they felt were important for others to know. They wrote these "fish facts" on paper cut-outs of salmon. The Grade 2s presented this information, in the form of oral presentations to the entire student body at their school's Earth Day assembly.

However, the children wanted to share more about their learning. They wanted to increase awareness about salmon restoration not only among the Lab School students, but among the Lab School families as well. In collaboration with teacher/librarian Chriss Bogert, Cindy and the children created "The Salmon News from the Grade Twos," a class newsletter that was distributed to each family in the school. The newsletter also provided an opportunity for the children to acquire skills in informational writing and publication design.



Bring Back the Salmon: The Lake Ontario Atlantic Salmon Restoration Program

Did you know Atlantic salmon are an endangered species? We are starting a program called Bring Back the Salmon. The Grade Twos at The Laboratory School are participating in this program. It is cool because you get to keep Atlantic Salmon in your classroom. Last time we had Atlantic salmon in Ontario was 140 years ago. The pioneers cut down all the trees. That made the streams very warm. That was good for their cattle so they could drink fresh water. It also made the mud slide into the water because the roots weren't holding the mud. That made the salmon leave because they need shade and rocks.

SAVE THE SALMON!

Excerpt from the class newsletter "The Salmon News from the Grade Twos"

Key Concepts: Soil Ecosystem

Subject & Skill Areas: Science, Math (Number Sense, Data Management), Visual Arts, Language Arts (Reading, Writing)

Focus of Inquiries: Soil, Worms, Fungi, Underground Animals

The Late Primary Years: Robin's Story

Focus of Inquiry: Soil and Worms

Starting the Environmental Inquiry Process

Throughout her years of teaching, Grade 3 teacher, Robin Shaw, has found that providing opportunities for hands-on exploration enables her to reach a wider range of learners. She says, *"It lights a fire within children to feel, smell, and watch things."* With this practical wisdom in mind, she began the school year with an inquiry into soil, an overarching theme that would allow her students to literally "dig in".

Robin was curious about the direction that children would take with this topic and how she could make it meaningful for them. As is her usual practice, she began the inquiry into soil with a KB Circle to find out what the children knew or wondered about it. Seated with the children on the carpet, she asked: "What do you know about soil?"

The discussion elicited a number of spontaneous questions and comments, which Robin wrote on a notepad. Many of the children's questions related to the composition and formation of soil: "How is soil made? What is it made of?" These questions would help to drive the inquiry and served to inform Robin's planning.

Robin encouraged the children to express their preliminary ideas and questions about soil before turning to authoritative texts about the topic, enabling her to assess their current understanding. For instance, she asked them to imagine a very deep hole in the ground outside, and asked: "What would look it look like if you were to jump in that hole? What would the walls around you look like?"

The children then had an opportunity to express their imaginings through art. Using pastels, they worked very hard to make beautiful depictions of what they imagined the inside of a hole would look like. For Robin, these drawings were very informative. They revealed, in many instances, various inaccuracies or a lack of knowledge about the structure of soil. Importantly, however, they represented an opportunity for learning and knowledge building as they represented the children's initial understandings at the outset of the learning process. To acknowledge the value of each student's current thinking to the learning process, Robin displayed each of their drawings outside the classroom for all passersby to see.

The students were asked to express their ideas in written form (See Photo 35). For Robin, the children's writing revealed both their conceptual understanding about soil and the quality of their written expression. As always, Robin provided options for the children to express their ideas, taking into account their varying skill levels and development. Students who were not able to express the fullness of their ideas in words could supplement their written theories with drawings, while others who were adept in both writing and drawing could take full advantage of both forms. As well, others could choose to do only a minimal amount of writing and drawing, and to share their ideas more fully through their contributions to KB Discourse.

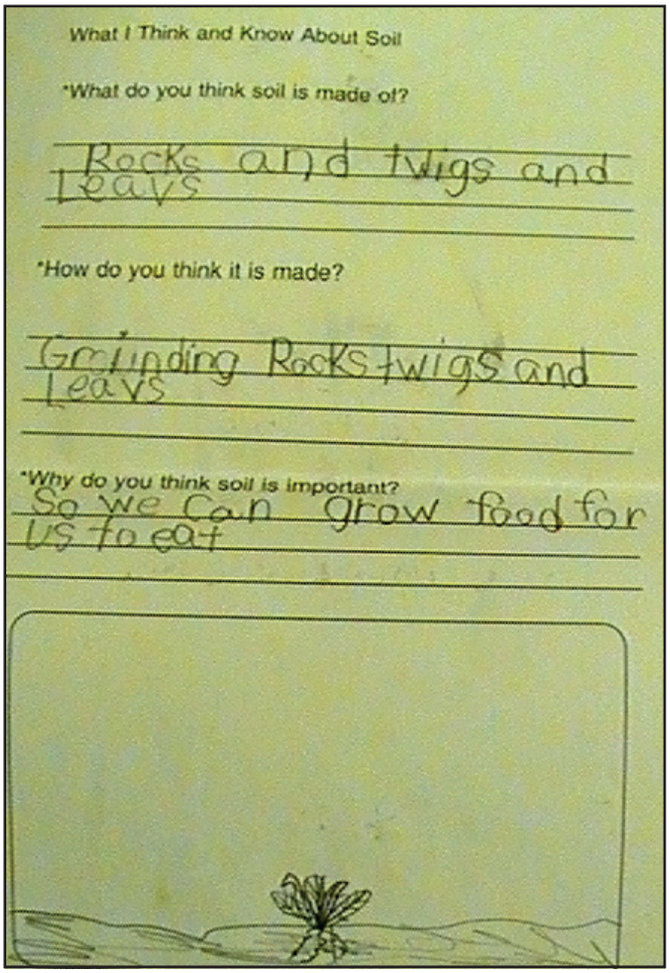


Photo 35: "What I Think I Know About Soil"

KB Circles were an integral part of this inquiry about soil. While the ideas of individual students were often only partially accurate, the combined knowledge of the community represented a fairly accurate understanding about soil (See Box 5). In the absence of KB Discourse, however, individual students would not have had the benefit of hearing and learning about the ideas of others. Moreover, they would have lost the opportunity to reconcile those ideas with their own.

The KB Discourse revealed the students' related interests, which ultimately influenced the direction of their inquiry into soil. For instance, during one KB Circle about the composition of soil, a student asked: "Why are there so many worms in this world?" More than a few students were curious about worms. Their questions about worms sparked questions from other students, and in no time the class was initiating an inquiry into worms.

Box 5:
Knowledge Building Circle:
"What is soil made of ?"

Student 2: I think that soil is made of twigs, compost, leaves, fungus, rocks, sticks, and animals.

Student 3: I think that it's made out of fungus and dead leaves and rocks and twigs that break down into soil.

Student 4: My theory is that it is made of rock that gets crushed over a few years with twigs and big plants.

Student 5: I think that soil is made of water and cracked up rocks.

Student 4: My theory is that soil is made out of sand and rocks and minerals.

Student 5: My theory is that a volcano blows up and lava forms up to rocks, so the rocks and minerals break down to form soil. Rocks are hard, but soil is soft with fertilizers that are white with little parts of gray.

Student 5: I have a question. Why are there so many worms in this world?

Grade 3 Questions about Worms…
Why are there so many worms in the world?
How do worms eat?
How do worms dig through the soil?
How do worms move?
Do worms eat leaves or soil?

Experiential Learning

"What is soil made of?" While the children had identified some initial theories about this question, they were able to improve their understanding by studying soil samples they had collected from the gardens and parks around their school, and from home. Barely containing their excitement, they dug into the soil with their bare hands, used magnifying glasses to examine the samples more closely. They documented their observations, using the simple record sheet Robin had created for them (See Photo 36).

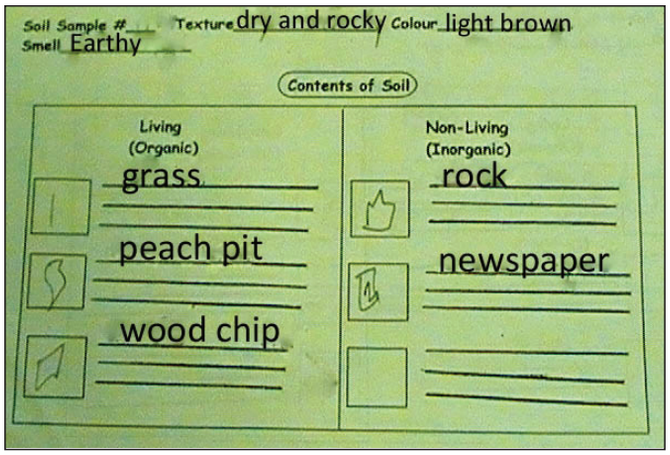


Photo 36: Soil Investigations*

* Text enhanced to ensure legibility. Original grammar has been maintained.

The children organized their findings according to the record sheet's two categories: living (organic) and non-living (inorganic). The record sheet was not only helpful to the children, as a record-keeping/organizational tool, but also to Robin, as a means of assessing their conceptual understanding about the difference between "organic" and "inorganic" items. Once their record sheets were completed, the children negotiated how to organize their findings into further categories such as rocks, living creatures, seeds, and plants, for the purpose of depicting this information in the form of bar graphs.

Both Inquiry-based and Experiential Learning emphasize that information is best accessed from a variety of sources, that no single book, person or experience will provide all the answers, or all perspectives that merit consideration. Robin recognized the fact that while the students' survey of different soil samples was an important part of their learning about soil composition, they needed outside expertise when it came to identifying substances such as sand, clay, silt particles, and humus.

To do this, Robin organized a field trip to the Humber Arboretum in the West end of Toronto. There, the Grade 3s had the opportunity to learn from soil experts, one of whom 'cooked up' a soil recipe especially for them. This recipe included two very important ingredients: water and air. This was enlightening for the students. They had been looking for solid contents in their soil samples, and had overlooked the presence of water, and especially, air.

Moreover, when a second expert showed the students a vermicomposter (a composter that uses worms), another "aha!" moment ensued. The children made the connections between soil, worms, water, and air: Worms help increase the amount of air and water that gets into the soil, thereby promoting a healthy soil environment. What's more, they also break down organic matter! All this information served to validate the Grade 3s' decision to redirect their inquiry into soil toward an investigation about worms.

Back in the classroom, the children were eager to continue their investigation of worms with the same scrutiny and documentation that they had exercised during their soil surveys. They investigated the question "How do worms move?" by using magnifying glasses to study worm anatomy and behaviour. They gently held the Red Wrigglers in their hands, touched different parts of their anatomy, and observed and documented the reaction of their worms (See Photo 37).

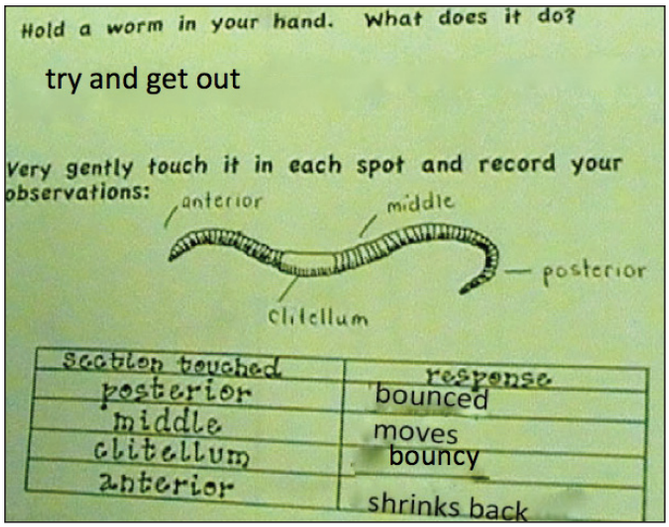


Photo 37: Anatomy of a worm*

* Text enhanced to ensure legibility. Original grammar has been maintained.

Integrated Learning

Student questions and the curriculum

A common misconception about Integrated Learning is that it solely entails the integration of more than one subject within the curricula. Teachers typically ask themselves: *"How can I integrate this Math expectation with this Science expectation?"* In an inquiry-based learning environment, however, teachers continually ask: *"How can I integrate the questions and interests of the students into the learning goals that I have for them?"*

Robin was willing to take the inquiry in the direction the children wanted. She was flexible in her thinking and planning, confident that the children's understanding about soil would continue to grow as they investigated worms, especially since these two aspects of nature are so inextricably connected. She highlighted this interconnected relationship, instead of focusing on a single, disconnected topic or unit. In this way, Robin demonstrated the true essence of Environmental Education. This approach aligns with the Ministry of Education's definition of Environmental Education as education "that promotes an understanding of rich and active experience in, and an appreciation for the dynamic interactions [emphasis added] of: the Earth's physical and biological systems" (2009a, p. 4).

To gain a deep understanding of any living species, be it worm, salmon or polar bear, one must also explore the dynamic interaction between that species and its habitat. This is precisely what the Grade 3s set out to do. After analyzing soil samples and negotiating their ideas in a Knowledge Building Circle, the students built a worm terrarium in the classroom to facilitate their investigation of the following questions: "How do worms dig through soil? What do worms eat?"

They sketched the contents of the terrarium and the changes that occurred over time and paid special attention to the worms' interactions with the soil. As Photo 38 demonstrates, integrating the children's questions led them to make important systems-thinking insights about the relationship between worms and their soil habitats.

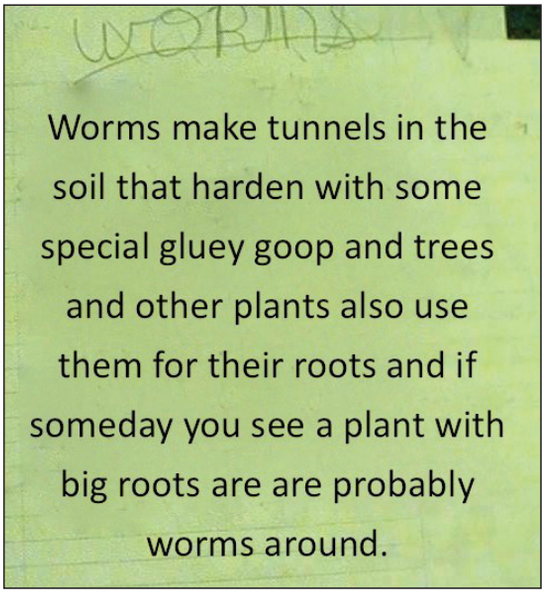


Photo 38: Anatomy of a worm*

* Text enhanced to ensure legibility. Original grammar has been maintained.

Math

Robin integrated Math into the inquiry by revisiting students' earlier questions about worms: "Why are there so many worms in the world? How do worms reproduce?" She asked the students to form pairs. Each pair of students introduced "Red Wigglers" into the terrarium, documenting the precise number of worms that went in. This information would establish a baseline from which to monitor the worms' reproduction over the course of one month. The children used mental math strategies to determine how many worms there were all together and how many new ones were produced over time.

Stewardship

The children's visit to the Humber Aboretum not only impressed upon them the important role that worms play in fostering healthy soil, but also inspired them to build their own classroom vermicomposter. The students divided up the workload for this project, such as cutting newspaper strips, preparing the screening, and adding organic matter. They watched over time how the Red Wrigglers transformed the compost into rich soil.

Throughout this observation, they asked questions such as: What is our relationship to worms? What is our relationship to soil? What is the relationship between worms and other life on Earth? They discussed these questions in Knowledge Building Circles and, as one child illustrated in his Inquiry Lab Book (See Photo 39), they considered the important role that worms play in the food chain by supporting the environment of other life forms.

Photo 39: The Importance of Worms*

* Text enhanced to ensure legibility. Original grammar has been maintained.

At this point, it made perfect sense for the children to participate in the Toronto Regional Conservation Authority's Aquatic Plants Program at Tommy Thompson Park (www.tommythompsonpark.ca), a wetland habitat restoration project in Toronto's urban wilderness. In the classroom, they planted seeds of aquatic plants, watched them germinate into plants, and planted their stock at the Tommy Thompson Park in the spring.

Focus of Inquiry: Fungi

Starting the Environmental Inquiry Process

The Grade 3s were utterly engaged with the topic of soil and worms that Robin wondered whether a related aspect of the soil ecosystem, such as fungi, would appeal to them as well. Indeed, it seemed to be the case: The children noticed and remarked upon the presence of fungi in their class terrarium. One child expressed his interest in a rare species of poisonous mushroom after reading *The Grim Grotto*, a book in the Limeny Snicket's series *A Series of Unfortunate Events*. The mushroom had poisoned one of the characters in the story. For these reasons, Robin followed her instincts and began an Environmental Inquiry into fungi with her class.

Robin opened the inquiry with a KB Circle, and asked the children, "What do you think or know about fungi?" The children shared personal experiences, theories, and questions (See Box 6). Robin recorded the main themes, questions, and misconceptions that the children shared to inform her subsequent plans.

This discussion was useful for generating the many ideas that the students would use in the writing task that awaited them. It was especially helpful for students who find that starting a piece of writing is challenging because they "can't think of anything to write". The exchange of ideas during this KB Circle activated their thinking about fungi. The students' ideas were already percolating by the time Robin gave them each a notebook and the instruction to express, in free form, their ideas and questions about fungi. Some children drew pictures of fungi or wrote personal stories and anecdotes. Others simply wrote down everything they knew and ever wondered about the subject (See Photo 40).

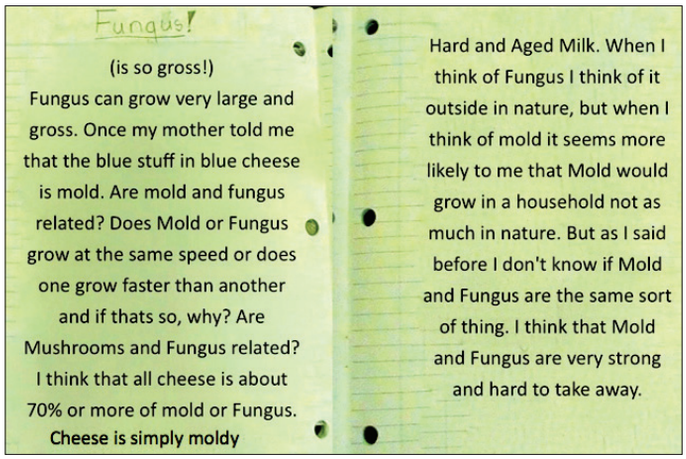


Photo 40: Wondering About Fungi*

* Text enhanced to ensure legibility. Original grammar has been maintained.

Robin's instruction was very inquiry-based and open-ended. There was no pre-defined agenda or format, and no right or wrong answers. The children could choose whatever form of expression they wanted to represent their ideas. In this way, Robin was able to glean information about the children's understanding in a non-threatening manner. The children's drawings and writings were a true representation of what the children knew and wanted to know, and what method of communication they preferred to use.

Robin plucked out common themes from the many questions and comments that emerged from the students' KB Discourse and written pieces. She used this information to shape the learning that would follow:

Common Questions among the Grade 3 Students

"How does a fungus form or spread?"
"What is fungus and mould? Are they the same thing?"
"Is fungi contagious?"

The children's investigation of fungi was a collective effort, not an assortment of individual research projects. It entailed considerable large and small group discussion, exploration, and research. The Grade 3s consulted books and the Internet and collected observational data. They made good use of their KB Circle time, sharing new information that came to light as a result of their research in order to visit and revisit questions both initial and emergent.

Box 6:
Knowledge Building Circle:
"What do you think or know about fungus?"

Student 1: Blue cheese isn't fungus.
Student 2: Blue cheese is fungus. Edible fungus.
Student 3: Not poison.
Student 4: Fungus is a relative of moss. We were baking this banana bread and my mom decided to put tangerines and we left them there for a little while and we saw green mosses start to grow.
Student 5: About what [Student 1] said: I don't think blue cheese is fungus. I think it's mould.
Student 1: I think they are the same thing.
Student 6: All cheese is mould. My mom told me. Blue cheese is blue mould.
Student 7: Fungus is the same family as mushrooms. My doctor told me I had mushrooms growing on my head but it was fungus.
Student 8: Mould grows on fruits and veggies and it's in cheese, fruit flies and creates mould on the fruit. Fungus grows on trees, rocks. Fungus can grow on pretty much everything. It might start up like a fist on a tree then it can spread down and up the tree. It's a lot of different colours, blue green, white, beige. Usually mould is white or beige.
Student 9: What I think is that cheese is actually mould. I'm not sure how you make it but the other day I was eating some cheese I saw all this mould growing on it. Also, on that big piece of fungus all sorts of small fungus grew and then it grew.
Student 10: Adding on to [Student 9]... When I came home from school two days ago I was going to have some bread and there was this white/bluish stuff on and it looked like mould. My mom said you shouldn't eat that because it's fungus/mould.
Student 2: About a week ago my brother was cutting himself some cheese and I looked at the blue cheese, there were blue patches and green on the blue so I think it is fungus and also moss.
Student 11: One day I was at my cottage and we sprayed the candy spray on the wall in the guest room and all this mould and moss started growing on the wall. It was stuck to the wall. Maybe there was already mould on the wall.
Student 12: Fungus is a living thing. It's a plant and you shouldn't touch it; there are things living in fungus.

Examples of collective knowledge advances

The Grade 3s theorized that fungi are more closely related to animals than they are to plants because fungi lack the chlorophyll needed for photosynthesis (See Box 7). They also came to realize that fungi share a similar function as worms because they help trees and plants grow by decomposing organic material in soil, making the soil rich in nutrients. They were fascinated about the fact that most fungi exist underground and that one particular fungus species, Armillaria Ostoyae (or the 'honey mushroom'), is one of the largest living organisms on the planet, sometimes covering approximately 8.9 square kilometers – approximately the same area as 1,800 football fields!

"You can't actually see a fungus because it's mostly underground and what you see is what's sprouting from it and what you see is how the things it's eating are changing." – Grade 3 student

Box 7:
Knowledge Building Circle:
Negotiating Ideas

Student 1: Once I was at the cottage last summer. I was jumping on the trampoline and then my dad pushed me off. I dove under the water under the trampoline and then I saw algae. My dad told me that algae are fungi that grow in the water.

Student 2: My theory is that algae aren't exactly fungi because algae are underwater aqua plants. Fungi are known not to be plants but to be something completely different. It has it's own kingdom! In fact fungi are closer to animals than to plants. I think that algae are NOT connected to fungi, but connected to plants. My theory is that there are different kinds of underwater fungi and maybe algae are connected to THAT type of fungus.

Student 3: Now that I think back, I disagree with myself and agree with you because now I remember that we had a class discussion together about that.

Experiential Learning

Teachers can make their students' learning more interesting and meaningful by connecting a given topic or subject to their personal lives. Robin regularly found opportunities to personalize the children's learning. For example, when a student exclaimed one day that he had noticed mould growing on bread at home, Robin responded to this child's cue by asking him to bring the mouldy bread to class so that everyone could examine it. Before she knew it, mould samples were showing up in the classroom daily! The class began examining this mouldy bread regularly with a microscope, eager to understand and answer the question: "How does a fungus spread?"

The students also learned about different kinds of moulds by consulting books and other research sources. By researching these authoritative texts, the students learned that the mould growing inside their class vermicomposter was Mycelium, a green and white thready fungus. The combination of close observation and authoritative research allowed the students to validate an earlier theory that was posited about the colour of fungi (See Box 6). As one student noted, "It's a lot of different colours: blue, green, white or beige. Mostly, mould is white or beige".

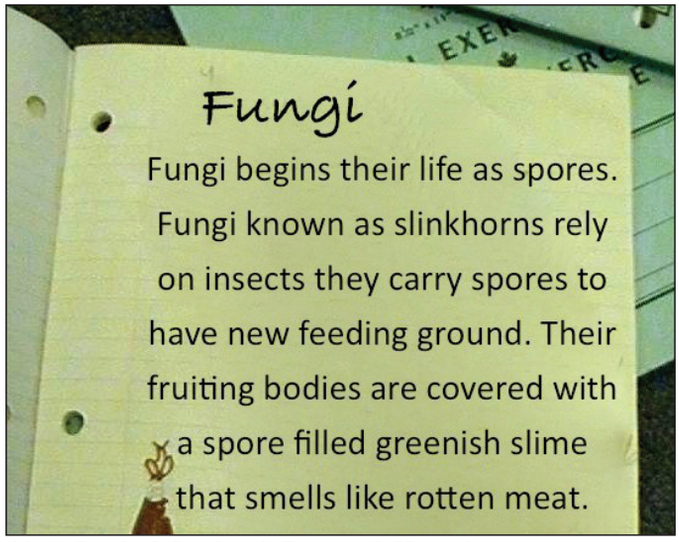
Integrated Learning

Reading, writing and research skills

In Grade 3, students are at the "Literacy for Growth Stage" in their reading development (Willows, 1994). They are shifting from "learning to read" to "reading to learn." Therefore, it was developmentally appropriate for Robin's students to apply their reading skills to their research on fungi by turning to the wide array of age-appropriate informational texts that Robin had procured from the public and school libraries.

Robin encouraged the students to write summaries of their readings, or of something they found surprising, in their Research/Inquiry Lab Books, where they had documented all of their ideas and learning throughout the year. Below are some facts that the Grade 3s found fascinating during guided reading and research:

- "A fungus is not a plant or an animal. Fungi have their own kingdom!"
- "When fungi are collected from rainforests, approximately one in every eight types collected is a species new to science."
- "Some mushrooms are quite capable of forcing their way up through asphalt and lifting paving stones as they grow."
- "The first antibiotic-penicillin is from a mould (fungus) and was one of the great medical advances of the 20th century!"



41: A Grade 3 Student's Research Notes*

* Text enhanced to ensure legibility. Original grammar has been maintained.

Visual arts

The students also studied the anatomy of a mushroom, not by simply looking at a diagram in a textbook and memorizing the labeled parts, but by examining the real thing, from every angle. They made illustrations of mushrooms, depicting their own perspective, what they knew and felt about them, rather than replicating someone else's vantage point.

Focus of Inquiry: Underground Animals

Starting the Environmental Inquiry Process

When the students had completed their inquiries into soil, worms, and fungi, they were still interested in learning about underground life. Now they wanted to learn about underground animals. As one child exclaimed, "I can't wait until we start our underground animal research!"

Robin had not planned for final projects. However, she felt confident about following this direction because the topic was so well-connected to the overarching key concept of the year: the soil ecosystem. Moreover, the students were highly motivated. They had been working collaboratively for most of the year and were more than ready for independent research.

Robin also recognized that this project-based direction represented an opportunity for each child to apply the skills and knowledge he or she had acquired over the preceding months. However, the children's questions and thinking would not be confined or relegated to the completion of this task alone. Rather, the research project served to honour each student's emergent questions and learning needs.

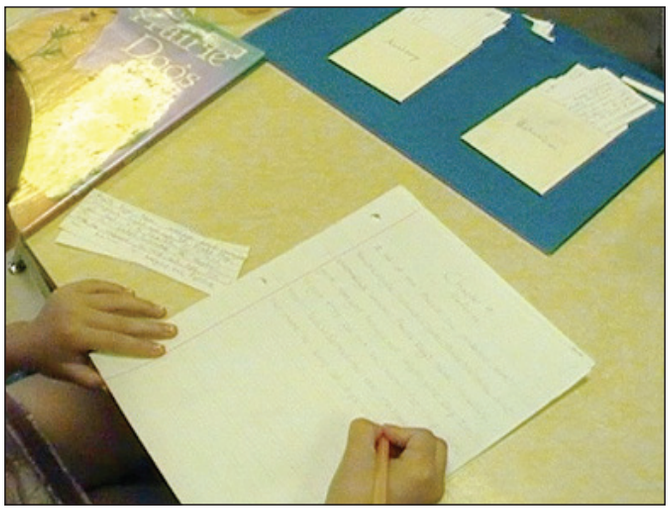
Robin began this inquiry by giving the children time to look at various books about underground animals, before having to decide which animal they each wanted to research. Some of the animals they chose were the prairie dog, fox, armadillo, and the chipmunk.

Integrated Learning

Project-based research

Robin had observed the children's method for collecting and organizing information about fungi, and concluded that they would need a better strategy to organize their research on underground animals. She consulted with another Lab School teacher, Zoe Donoahue, who had taught Grade 3 for a number of years. Zoe shared with Robin a helpful strategy: the creation of research folders with designated pockets for different categories of information.

Robin glued card pockets onto re-purposed file folders and gave one to each student. Together, Robin and the Grade 3s engaged in a discussion about the features of non-fiction texts. Then the class brainstormed the following categories together, which they used to label each of their card pockets: Classification, Food, Behaviour, Anatomy, and Habitat. The students were already familiar with these terms through their inquiry into soil and worms. The children were provided with index cards on which to write jot notes of their research from books. It was up to each student to decide the most appropriate pocket/category in which to place his or her index cards.



This was truly an exercise in the use of critical thinking skills, particularly when an index card seemed to fit into more than one category. Nevertheless, each student was able to consolidate all of their research in an organized fashion, which made it easier to move on to the next steps: deciding the order in which they would present their research, and turning their jot notes into full sentences and paragraphs.

Visual arts

Understanding the anatomy of their chosen underground animal was an integral part of the children's research. By sculpting their animal in clay or plasticene, the students were able to appreciate this aspect more fully as it required them to consider anatomical details from all vantage points and in three dimensions.

Key Concepts: Biodiversity, Government

Subject & Skill Areas: Science, Math (Measurement), Visual Arts, Language Arts (Reading, Writing), Social Studies (Government), Research Skills, Critical Thinking Skills, Media Literacy, Oral Communication Skills

Focus of Inquiries: Plant Biodiversity, Governmental Responsibility for Environmental Issues, Environmental Awareness Documentaries

The Junior Years: Ben's Story

Focus of Inquiry: Plant Biodiversity

Starting the Environmental Inquiry Process

Before the start of the new school year, Grade 5/6 teacher, Ben Peebles, had thought about how best to start an inquiry on the concept of biodiversity with his students. He was curious about their interest in plant life – what they already knew and what they were wondering about – and he wanted them to have some preliminary hands-on experiences that would familiarize them with the domain and spark their curiosity.

On the first day of school, Ben got started. No sooner had his students entered the classroom, were they bustled back outside into the schoolyard, armed with trays and brand new Lab Books. They were on a biodiversity "quest". Their challenge was to discover, to record and/or to collect samples of as many different living things they could find in the yard.

After only an hour or so of digging in the dirt, the Grade 5/6 students were surprised to discover that they had unearthed more than 50 different species of weeds, flowers and insects. To differentiate their samples, they made sketches and took notes:

"Dandelion: 5 inches tall, not yet a flower. Purplish leaf: approximately 4 inches tall and 1.5 inches across; black and brown spots" (See Photo 42).

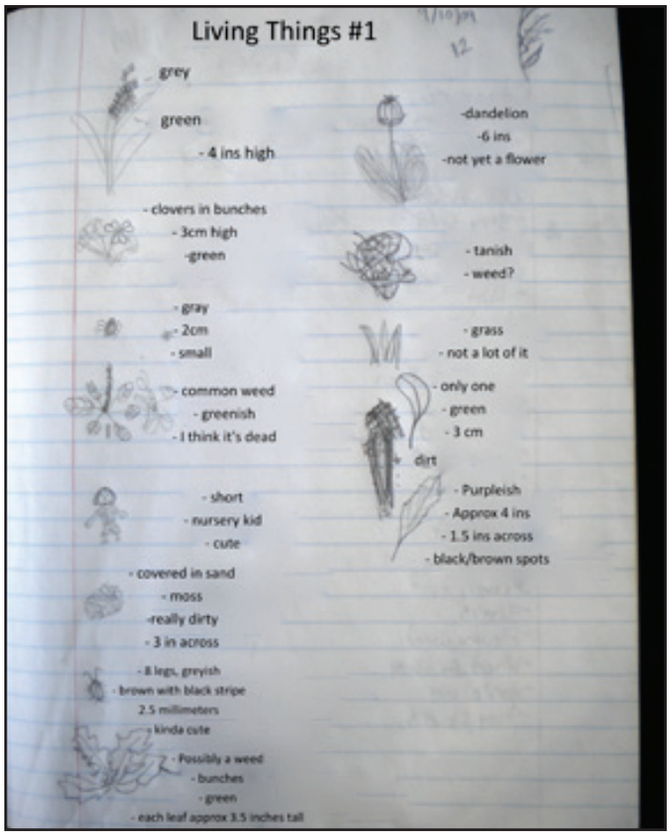


Photo 42: A Grade 6 Student's Field Notes*

* Text enhanced to ensure legibility. Original grammar has been maintained.

The students experimented with the science of taxonomy in order to make sense of what they had found. Working in small groups, they sorted their collections and classified their various findings into categories. These preliminary categories represented their initial theories about the manner in which living things are classified.

Ben reconvened the class and encouraged the students to negotiate their ideas about classification with the goal of reaching a consensus on a classification system. The students came up with two classification categories: Plants and Animals (See Photo 43). They also created a "To Classify" category because they could not determine where some samples fit (e.g., mould, fungus and moss). The class theorized that moss was a plant but were unsure because it did not have the same kind of root system that was typical of plants.

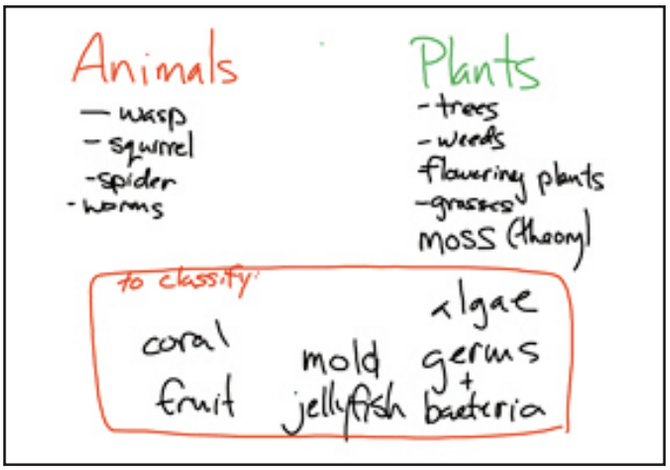


Photo 43: Classifying Living Things

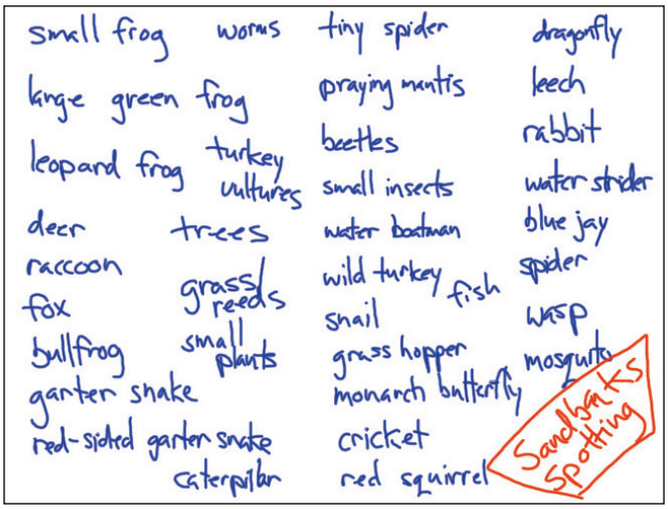


Photo 44: Sandbanks Spottings

Ben responded to their ideas and encouraged them to pursue this problem in understanding. He brought to class a moss-covered rock and asked the children to examine it and to debate the following questions in a Knowledge Building Circle: "Is it a third category? Is it a plant? How would we know?" The students' responses were revealing, enabling Ben to discern their initial understandings about what makes a plant a plant and what makes an animal an animal.

More "lead-in" experiences

The schoolyard inquiry primed the students' interest in biodiversity, setting the stage for a mid-September excursion to Sandbanks Provincial Park. Located in Picton, Ontario, Sandbanks is home to a remarkable array of vegetation and wildlife. The students spotted numerous living creatures that were not part of their schoolyard's ecosystem, which greatly added to their excitement.

Once back in the classroom, Ben asked the students to gather as a group to share their experiences at Sandbanks and to compile a list of all the organisms they had seen (See Photo 44). In this instance, Ben was hoping to get a sense of the students' ideas – not about the classification of living things, but about the connections and interrelationships between them. He asked the children, "How are these living things connected to one another?"

Working in pairs, the students conveyed their understanding about the interrelationships between the different organisms they had spotted by creating their own visual depictions of food webs (See Photo 45). Food webs are complex networks of related food chains that show how plants and animals in an ecosystem are interconnected through the movement of energy via multiple predator-prey relationships. The students' efforts to create these webs represented their initial ideas about the importance of biodiversity. By analyzing the complexity of these images, Ben could assess the depth of each student's understanding of the interrelationships between organisms and the importance of biodiversity. This activity led to a discussion about how the loss of a single species could weaken the stability of the ecosystem.

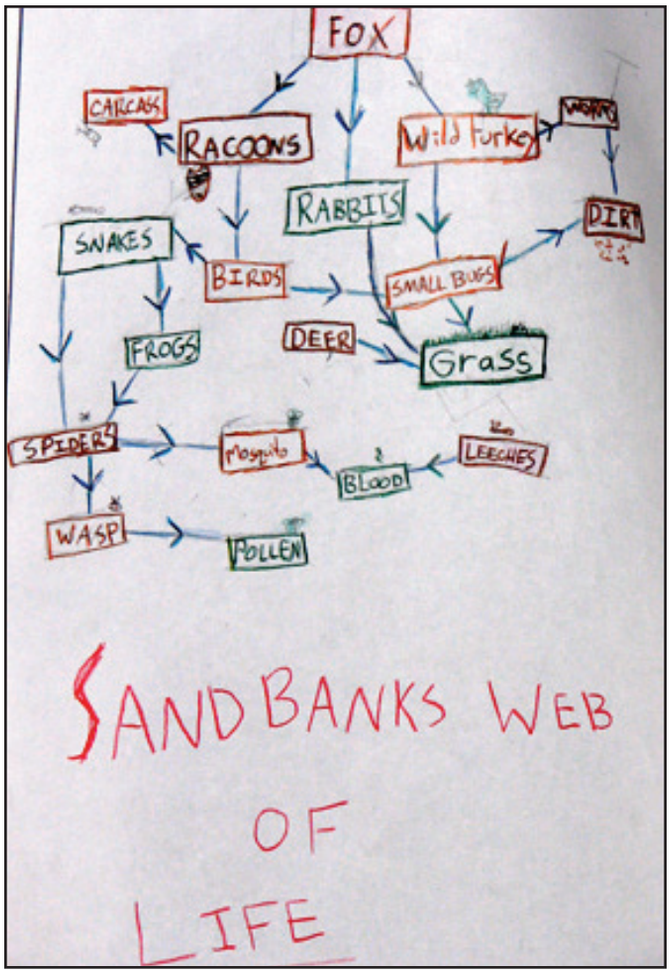


Photo 45: A Student's Food Web

Crafting questions

Through these lead-in experiences, Ben felt confident that his students were now familiar with and curious about biodiversity. They even expressed an interest in designing experiments as a way to learn more about plant biology. For Ben, this was an opportunity to engage the children in a discussion about what makes a meaningful scientific question. The children's insights about this question were interesting and helped to guide them toward asking questions that would advance the knowledge of the group (See Photo 46).

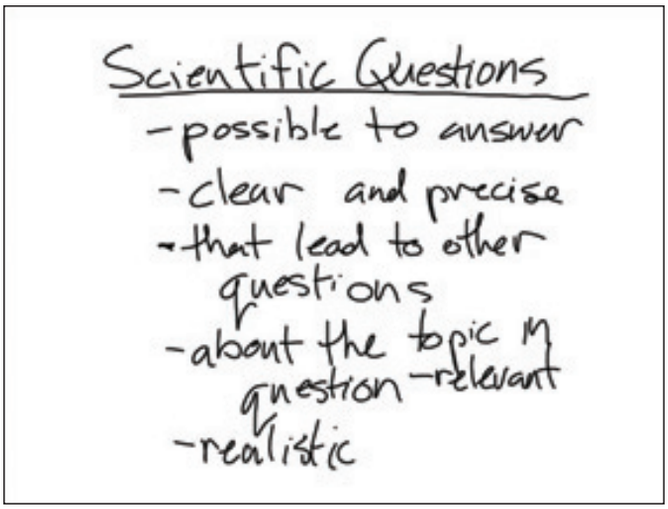


Photo 46: Characteristics of Scientific Questions

The next challenge was to determine which specific questions should be pursued. The class had established that a scientific question is one that can be investigated through experimentation, observation, and/or research in authoritative sources. They chose to sort their questions into these categories by deciding which investigative method would be most suitable for each query. Since the students were particularly interested in designing their own experiments, they decided that the 'experimental' questions would drive their inquiry.

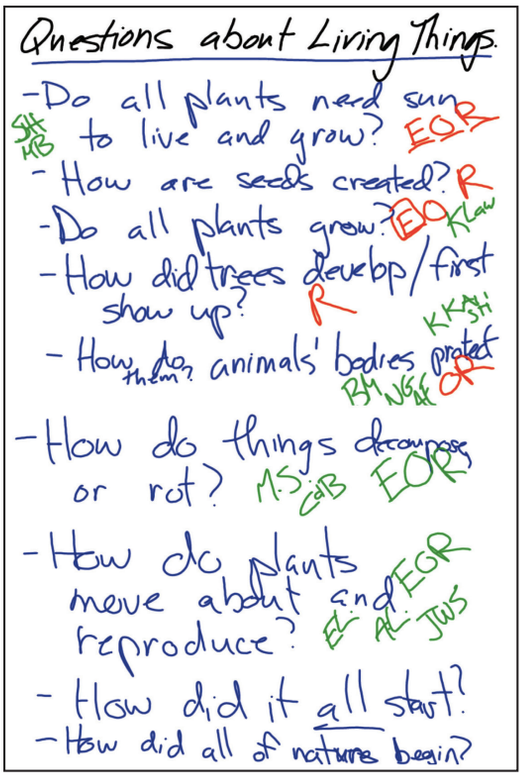


Photo 47: Students' Questions about Plant Biology

Experiential Learning

Once the students had decided on the questions, they began designing their experiments using a hands-on, experiential approach. Although the children led the direction of their inquiry, Ben played a critical role as mentor and co-learner, monitoring the students' experiments and introducing resources to facilitate their understanding. For example, when he noticed fungus growing in a terrarium, he introduced an authoritative reading about fungus to help the children understand what was happening in their experiment.

The class discussed what makes a good experiment (e.g., the need for a "control" if an experiment involves a comparison; how to make observations; how to ensure an experiment is "reliable"). Rather than simply explain the elements of effective experimental design, Ben encouraged his students to consider questions that would feed into this overarching theme: "If you are comparing two things but you're changing all kinds of variables, how would you know what exactly accounted for the change that you are looking for?"

Experiment #1: "How do invasive species take over or affect an ecosystem?"

The students created a terrarium in which they planted both a native plant and a tropical plant. They observed and recorded apparent changes on a regular basis in their Inquiry Lab Books in the form of drawings and written descriptions. Through close observation and documentation, and through reading and research of informational texts on invasive species, the students were able to make informed theories about the phenomena they were observing. For instance, after observing that a tropical plant was thriving in the humid conditions of the terrarium, while the native plant was wilting, the students working on this experiment made the following theory: "The invasive plant is surviving because it could be used to lots of water" (See Photo 48).

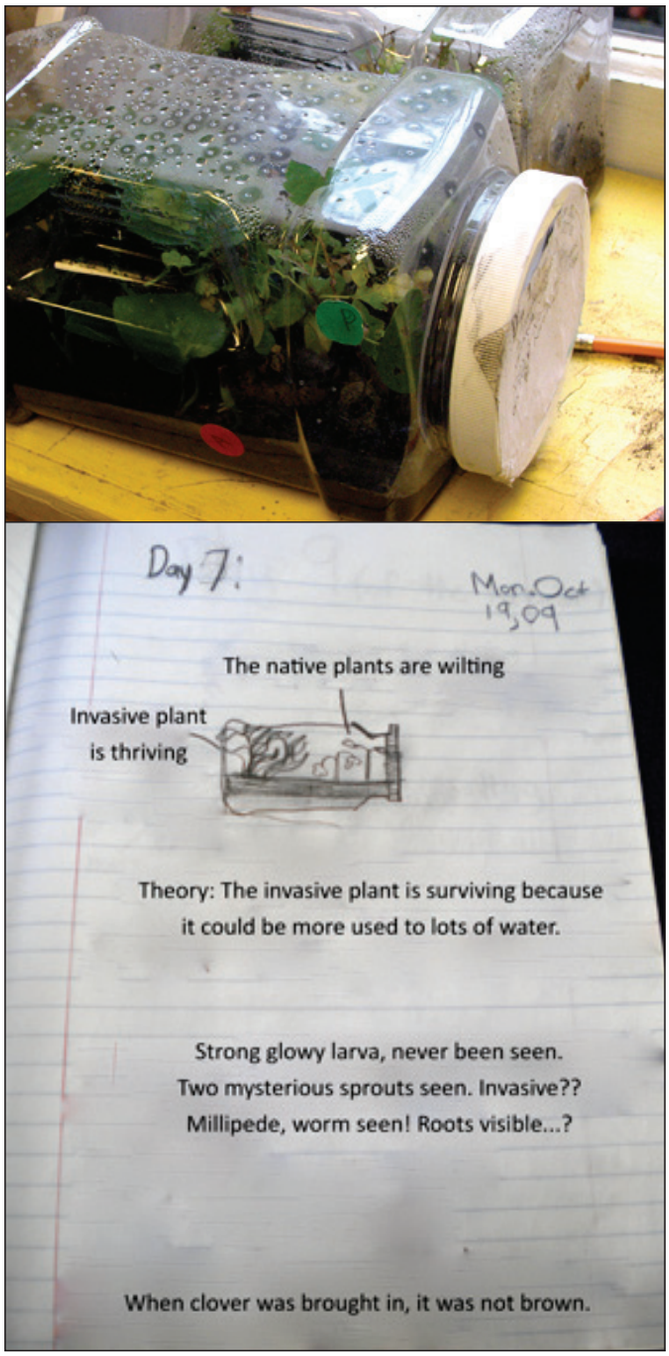


Photo 48: Documented Observations of Day 7*

* Text enhanced to ensure legibility. Original grammar has been maintained.

Box 8:
Knowledge Building Circle:
"Do all plants need sunlight to live and grow?"

Student 1: Our question is: Do all plants need sun to live and grow?
Student 2: What we noticed is that the sunlight plant has used up a lot more water than the one in the box. We think that it is because the one in the sunlight needs to make the cellulose to help make it grow. The sunlight plant has used up 2 cm of water.

Student 1: But when we first filled it up, the plant in the box had less water.

Ben: So your theory is that maybe photosynthesis isn't happening here. Does anybody want to build onto that?

Student 3: It says here [in this article] that in the sunlight the chloroplasts with the chlorophyll inside them build up food inside them, and I guess they expand. Maybe they pop or something like that to distribute the food.

Ben: What would that explain about the observation?

Student 3: That they can't make chloroplasts because they don't have any sunlight. That's why we see the colour, the weakness being different.

Student 4: Building onto [Student 3], I think that the colour is different because when the leaves turn colours in the fall it's because they don't have chlorophyll anymore because they don't get as much sunlight. So it could be just like the same thing with the plant in the box.

Student 1: So then, what we should do maybe in a week is take a sample of the leaves and soil and look at them under the microscope to see the difference between them.

Ben: What would you be looking for if you did that?

Student 2: We would be looking at the chlorophyll and chloroplasts to see if there is any difference.

Experiment #2: "Do all plants need sunlight to live and grow?"

These students planted two of the same plant species, each in separate cups. One plant was exposed to plenty of sunlight and the other was placed in a shoebox in a dark location.

One of the most significant learning outcomes of this inquiry occurred during a Knowledge Building Circle (See Box 8), a time when the entire class comes together to share ideas and insights. During this particular KB discussion, each group shared the progress of their experiment, exchanged insights, and contributed theories and problems of understanding with the whole class.

To Ben's delight, one of the research groups had made careful observations of everything that was happening in their experiment, including things that at first glance appeared unrelated to what they were actually looking for (See Photo 49). This group's question was: "Do plants need sunlight to live and grow?"

Question: Do all plants need sun to live and grow?

	Measurement		Soil		Water Measurement		Picture/Facts
Tues	light	dark	light, dry	dark	Light, halfway	dark	
Thurs	14cm	12cm	wet	wet	6½cm	5½cm	Dark
Tues	14cm	8cm (squished)	wet	wet	5cm	5½cm	Squished
Thurs	14cm	6½cm	wet	damp	4½cm	5cm	Dark, not squished
Tues	14½cm	5½cm	wet	wet	4cm	5cm	Can't photosynthesize
Thurs	14½cm	5 cm	wet	wet	3cm	5cm	Shrinking, still not dead
Tues							

Photo 49: Accounting for all variables*
* Text enhanced to ensure legibility. Original grammar has been maintained.

Their experiment, as they conceived it, was about understanding what happens to plants when they are not exposed to sunlight. Sunlight was the key variable and everything else had been controlled for. They had even created an automatic watering system for the plants and had measured the amount of water that each plant was taking in. They found that the plant that was in sunlight took in more water than the plant that was "in the dark".

This was a key observation, which led them to theorize that a plant cannot photosynthesize effectively without sunlight and therefore does

not take in as much water. The group was able to make connections between sunlight, water, and the process of photosynthesis. They shared their depth of understanding with the class and harnessed the class' input to move the experiment forward. For instance, in the midst of a Knowledge Building discussion, another classmate built on this theory, suggesting that one might be able to tell whether photosynthesis was occurring by looking at the chloroplasts. This student's idea was based on a recent reading, from which he learned that chloroplasts are a central site for the photosynthesis process. Based on this suggestion, the students designing this experiment knew how to test their new theory: They decided to examine cell samples of each plant under a microscope to look for differences between the chloroplasts in each experimental condition.

This Knowledge Building Discourse advanced the understanding of the collective group: The class had a better grasp of the process of photosynthesis. They also understood the approach that each group needed to use to continue their own experiments. The students learned about the importance of process, specifically that "when doing an experiment, measure everything and observe everything, because one never knows what will turn out to be important".

All of this was possible because Ben ensured that each inquiry period had a regular block of time for the students to share their developing understanding. Ben typically reserves the largest uninterrupted block of time available in the week for integrated inquiry (usually 1.5 hours, 2 times per week). The children work on their experiments and research during the first part of this block; the last 25-minutes are reserved for KB Discourse, where the whole class comes together to share new understandings or new questions. Students sometimes have a lot to report and they'll say, "This was really hard for us to figure out. Here's what we think, but we're not sure. We have to read more about it". Ben documents these conversations for future reference and later discussion. It is this process of open communication that allows students to learn from one another as a true community of learners.

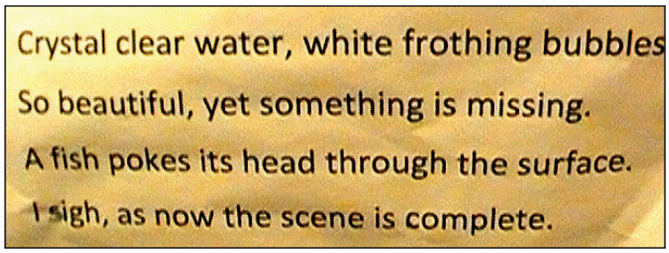
Integrated Learning

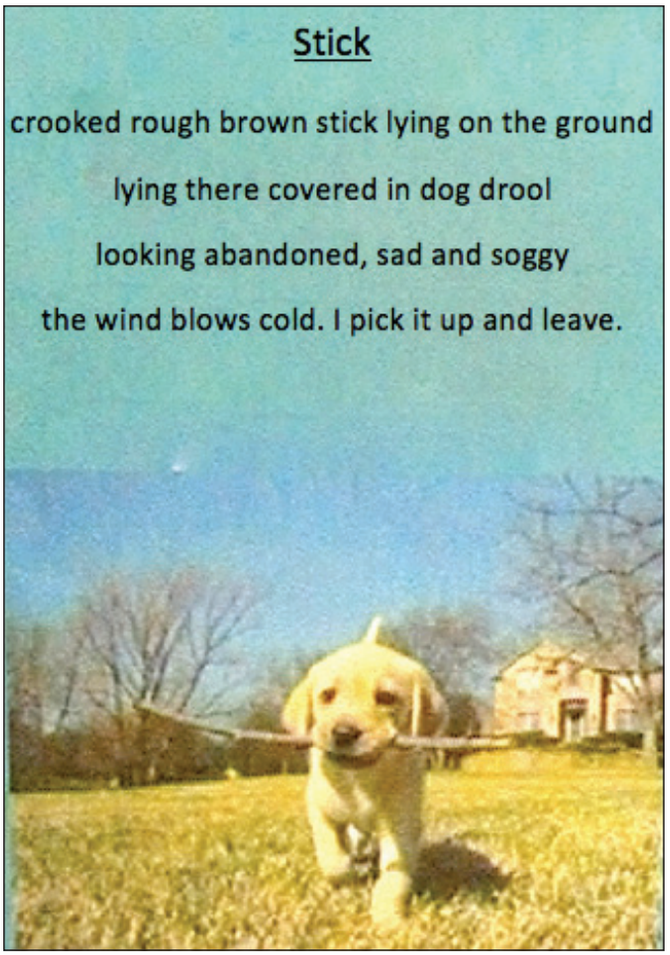
Poetry, descriptive writing, and figurative language

The Grade 5/6s also demonstrated a poetic appreciation for the natural world. Indeed, the same detailed observation skills which the students applied to their scientific experiments may well have enhanced their ability to both "notice" and convey in words, the small but compelling details of nature that have inspired poets throughout the centuries.

The children's poetry in this section reveals a different way of knowing and relating to the environment. Here, the students move beyond the realm of science to contemplate the beauty of life around them. They use literary devices, such as personification, simile, and point-of-view, to express their regard for the natural world and their understanding that all manifestations of nature, even "an abandoned stick", are but one part of an interconnected whole.

* Text enhanced to ensure legibility. Original grammar has been maintained.





* Text enhanced to ensure legibility. Original grammar has been maintained.

Reading comprehension, summarizing, paraphrasing and writing conventions

The children demonstrated their understanding of the interconnectedness of all living things by writing summaries of various readings that Ben had procured for them about the classification of living things. The larger objective of these written summaries was to advance the collective knowledge of the class. As there were many articles to read, and not everyone would have an opportunity to read each one, Ben asked each student to read a different article and to write a summary of it that would be distributed to everyone in the class. By the end of this process, each student would have read one full article and summaries of all the others.

The students recognized that this activity was "authentic". They were not writing summaries for the teacher (whom, it could be assumed, had read all of the articles and therefore didn't need to read a summary). They were writing them for each other, to advance the knowledge of the group. The summaries, therefore, needed to be informative and coherent because others were going to read them without the benefit of having read the original articles.

These summaries also provided Ben with important assessment information. Without making it obvious to his students, Ben was able to assess a number of different skills related to Language Arts within the context of his students' scientific inquiry. Indeed, this non-threatening, purposeful writing task allowed him to answer the following questions about his students' reading comprehension and writing skills:

- "Has this student demonstrated an understanding of the main point of the text?"
- "Is this student able to select the most pertinent information to create a concise summary?"
- "Is this student able to paraphrase information in his or her own words?"
- "What does this piece of writing tell me about this student's writing conventions?"

Focus of Inquiry: Governmental Responsibility for Environmental Issues

Starting the Environmental Inquiry Process

Photo 50: Parliamentary Debates in Grade 5/6

In the first term, the Grade 5/6s explored environmental issues, such as biodiversity, from a science perspective. In the third term, they began their Social Studies inquiry into the role and responsibilities of government with regard to the environment. This meant a fundamental shift in perspective: from looking at the environment through the lens of scientific inquiry to looking at the environment through the lens of social policy. It soon became apparent, however, that their improved understanding about the importance of biodiversity, and their growing concern about the vulnerability of the earth's natural systems, would shape the manner in which they came to understand the roles and responsibilities of government. Their inquiry into biodiversity seemed to linger in a deep-seated way that would continue to inform their thinking about other domains.

For this particular inquiry, Ben initiated Knowledge Building Discourse that would reveal his students' understanding of social policy issues and elicit their questions. Ben asked: "What do you think are the most important issues facing the Canadian government today?" He had already set the stage for this inquiry through a weekly "news period" during which students each presented a written summary of an issue that was discussed in a newspaper article of their own choosing. This served to initiate discussion and to familiarize the students with government policy concerns. Ben now felt confident about his students' readiness to contribute to Knowledge Building Discourse concerning Canada's government.

Many of the students were of the opinion that the environment was either the most important issue or among the top three most important issues facing the government. The students debated various policy options that the government could use to address various environmental challenges, from climate change to pollution to the degradation of the Great Lakes. They debated issues such as: "Should plastic bags be banned? Should car idling be restricted? Should the government invest money in bike paths?" (See Box 9).

These debates about the feasibility of 'green living' required the students to exercise their critical-

Box 9:
Knowledge Building Circle:
"Should plastic bags be completely banned in Toronto?"

Ben: Who is in favour of this idea?
Student 1: I fully support the idea that plastic bags should be banned because it takes 800 years for them to biodegrade and wildlife are eating them and dying. Paper bags should also be banned.
Ben: Who would like to speak from the other point-of-view?
Student 2: Are we going to use reusable bags to put our garbage in? If you pick up after your dog, what bags are you going to use? Are you going to clean out your the reusable bag every time you pick up after your dogs? That would be disgusting. What bags would we use to put our actual garbage in?
Ben: Is there anyone who is undecided and who would like to share why you are undecided?
Student 3: A lot of the reasons that people stated so far are not convincing. If you brought your own bag, you get a discount, but if not you just have to buy a plastic bag. That would work because people forget their bags at home.
Student 4: I was going to vote for the ban but they should make biodegradable plastic bags, and people should use them more because they are really good.
Ben: So you're thinking a different type of solution would be better?
Student 5: Dog owners and dog walkers might need them. That's their job. If you ban them there will be all kinds of issues for them.
Student 6: We also think that biodegradable plastic bags would be good. If plastic bags are banned completely, the city will smell really bad because nobody will pick up after their dogs.
Student 7: I think they do actually make biodegradable plastic bags. There are special bags for picking up dog poo. I have them. I think we are not being creative enough. Our solutions are far too simple. If the pet companies are making biodegradable plastic bags, why don't we?
Ben: So are you saying yes or no?
Student 7: I'm saying yes. Even with the biodegradable kind, though it should still be recommended for people to use reusable ones because the oxy-biodegradable bags take two years to biodegrade.
Student 1: I think the plastic shopping bags at least should be banned.
Student 8: Not ban them completely. Just reuse the biodegradable plastic bags. Don't forget that you can reuse plastic bags too.

thinking skills and highlighted two important understandings: 1) There is more than one perspective on an issue, and 2) There are many factors to consider when implementing a policy.

These discussions led to larger questions that informed the children's approach to "investigating" government: "How can we influence the government to pay more attention to environmental issues? How does the government make decisions about the issues we care about?"

Experiential Learning

As Hootstein (1995, p. 24) rightly asks, how does "learning by doing" happen in a curriculum area that is "traditionally anchored in lecture, recitation, and textbook learning?" Moreover, how do 10- and 11-year-olds come to understand Social Studies topics, such as Canada's government, through experiential learning? The Grade 5/6s' investigation *"How do governments make decisions about the issues that we care about?"* demonstrates that Experiential Learning can both motivate and enrich student learning in content areas typically associated with 'book learning' alone.

Ben's class began their inquiry by identifying an issue of particular concern to them as revealed in a class survey: that car idling contributes to greenhouse emissions. They decided "to become politicians" in order to understand how and why governments pass legislation. Through role playing, they had opportunities to debate and practise their persuasive writing and speaking skills as they presented their proposed bills to the "House". They responded to objections, revised their draft bills, and presented them once again. They learned to appreciate that politicians must consider a range of issues such as: How much would this cost? Would citizens agree to this law? Who would enforce the law? Where would monies from collected fines go?

For the class to 'pass' a law that had the support of the class, they needed to understand how real laws are passed, the roles of various levels of government, and the types of legislation for which governments are responsible. At appropriate moments, Ben provided essential readings to support their investigation. The students took jot notes in their Inquiry Lab Books, recording pertinent information about the policy-making and legislative processes that would help them in their roles as policy-makers and politicians.

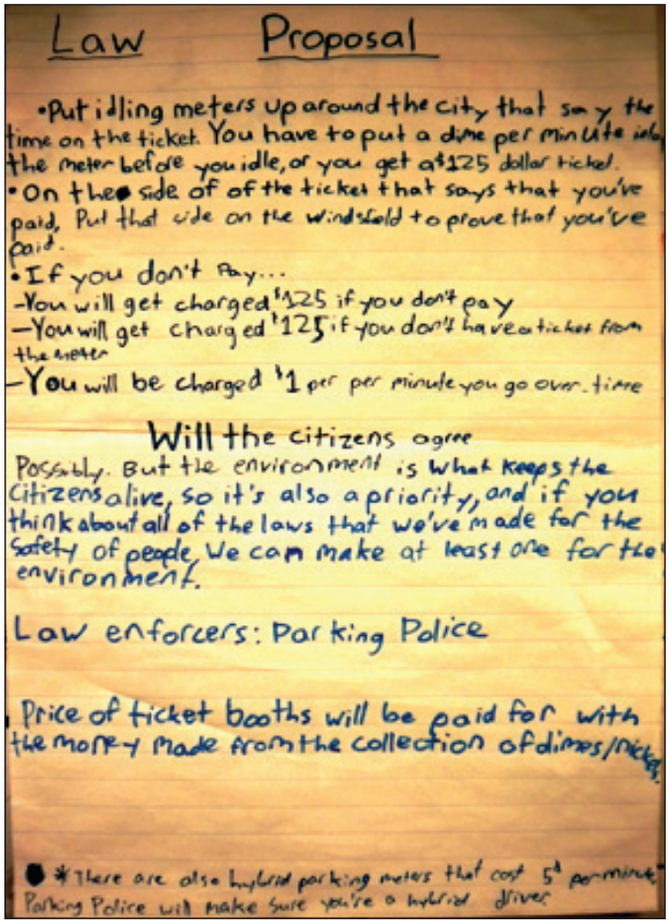


Photo 51: Car Idling Law – Proposal 1

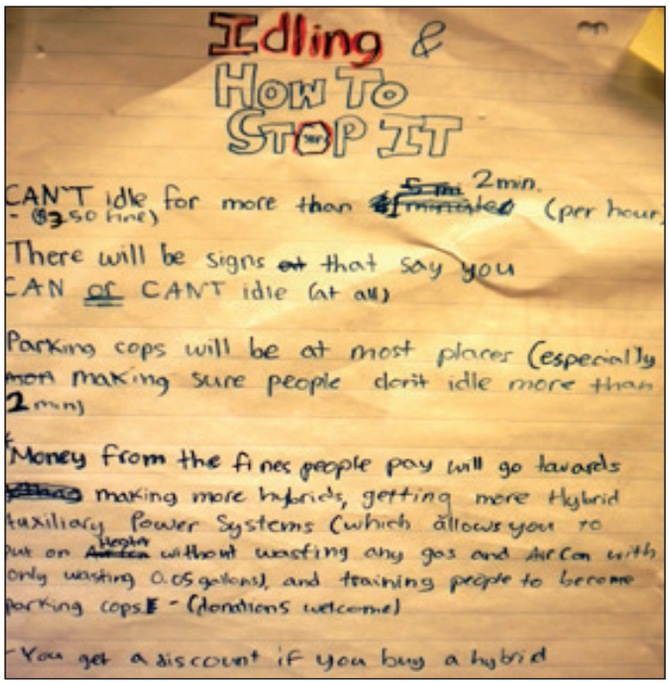
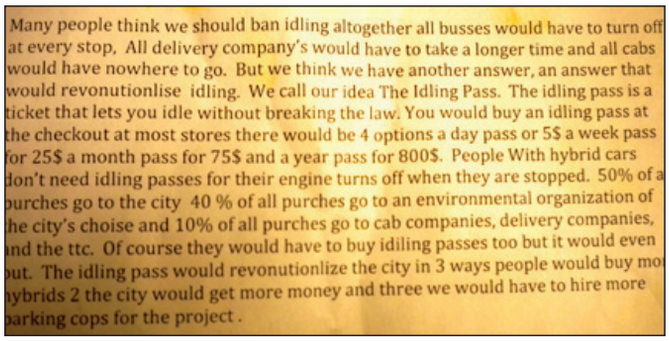


Photo 52: Car Idling Law – Proposal 2



Many people think we should ban idling altogether all busses would have to turn off at every stop, All delivery company's would have to take a longer time and all cabs would have nowhere to go. But we think we have another answer, an answer that would revonutionlise idling. We call our idea The Idling Pass. The idling pass is a ticket that lets you idle without breaking the law. You would buy an idling pass at the checkout at most stores there would be 4 options a day pass or 5$ a week pass for 25$ a month pass for 75$ and a year pass for 800$. People With hybrid cars don't need idling passes for their engine turns off when they are stopped. 50% of a purches go to the city 40 % of all purches go to an environmental organization of the city's choise and 10% of all purches go to cab companies, delivery companies, and the ttc. Of course they would have to buy idiling passes too but it would even out. The idling pass would revonutionlize the city in 3 ways people would buy mo hybrids 2 the city would get more money and three we would have to hire more parking cops for the project .

Photo 53: Car Idling Law – Proposal 3

Integrated Learning

The children also investigated the question "How do people influence the government to take action on matters that we care about?" through direct contact with a local City Councillor.

The local Councillor visited the Grade 5/6 class to answer questions about the role of government in addressing environmental issues. Students' questions included: "Is it hard to decide if you want a Bill to be passed? Who is responsible for cleaning up all the litter in the parks? What is the most important thing that kids can do to help?"

Through this conversation with a real politician, the students learned that the decision to pass a bill can be difficult because it involves balancing the interests of different groups of people. The Councillor informed the students that their voice is important and that they can write a letter to their local Councillor to express their concerns.

The students were soon writing formal letters to the City Councillor about their environmental concerns. For most, this was their first experience in environmental advocacy.

Stewardship

The students' political debates on environmental issues sparked their interest in the root causes of these challenges. In pursuit of these interests, the class researched issues ranging from climate change and methane gas to hybrid cars.

The students worked in pairs to create documentary films about their chosen research topic. They gathered information from a variety of sources including books from the school and public libraries, readings and videos that Ben brought in, and the Internet. They learned how to incorporate a variety of media including photos, video clips, text, interviews, music, and commentary to create a compelling message and promote a potential policy solution. Some of the film titles included:

- The Last of the Koala Bears Trees: Why is Protecting Them Important?
- Urban Sprawl: The Habitat Destroyer?
- The BP Oil Spill and its Effect on Animals
- Water Pollution in the Great Lakes and its Effects.

To broaden awareness within the school community, the Grade 5/6 classes hosted a Documentary Film Festival, to which other classes in the school were invited to watch films and to hear their proposed solutions, such as shifting more renewable sources of energy including biomass, wind or solar energy. Inspired by the knowledge gained through this experience, the Grade 5/6 students also brought their concerns to The Lab School's 'Green Team,' who then looked into the possibility of introducing alternative energy sources at the school and at ways to reduce the school's energy consumption levels.

Key Concepts: Growth and Change, Water in the Environment

Subject & Skill Areas: Personal and Social Development, Science, Arts, Language (Oral Language, Writing, Reading)

Focus of Inquiries: Decomposition, Water Pollution, Water Cycle

Victoria Village Public School

About Victoria Village Public School: Urban school located in the east end of Toronto. The student population represents a variety of language groups and families from diverse cultural backgrounds, with 65% of students speaking a primary language other than English.

Grades JK/SK: Perri's Story

Perrianne Evert has taught for 18 years at various schools and grade levels, from JK to high school ESL, although most of her experience has been in JK/SK and Grades 4/5. Her first experience of Inquiry began last year in kindergarten math class, when she asked the children how they were going to measure the classroom pumpkin.

"I was fully intending to show them how to use standard-size blocks," Perri recalls, "but then one young student piped up, *'We could use our hands.'* So, reminding myself that Inquiry is about honouring children's questions, I took this child's cue."

The children soon discovered that using their hands for measurement was not particularly effective because their hands differed in size. For Perri, this was an "aha!" moment. Now was the perfect time to introduce the blocks. The children were more than "primed" for this measurement alternative. In fact, they regarded the blocks as a miraculous invention. Likewise, Perri was thrilled. "This tiny piece of teaching was like a miracle to me and I did not want to stop!"

Focus of Inquiry: Decomposition

Starting the Environmental Inquiry Process

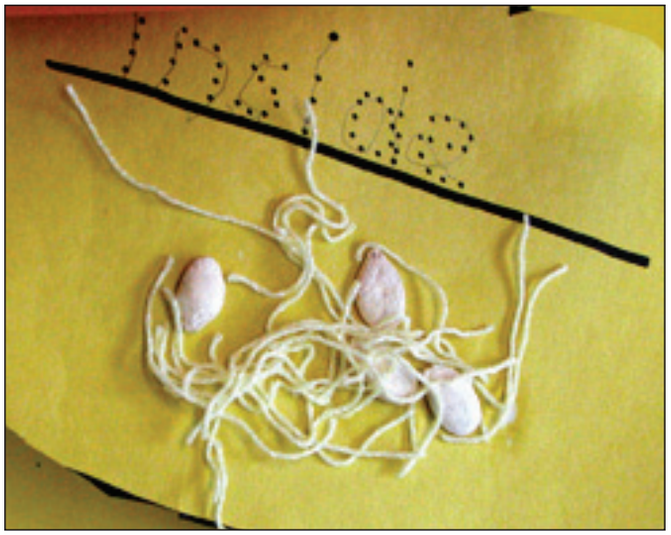
The Growth of Pumpkins

It was October, the season for harvesting. Just outside Perri's classroom, there was a courtyard with a small pumpkin patch and garden that had been planted the previous spring. This was a perfect opportunity, Perri realized, for her students to learn about growth and change in nature, and so she organized a series of activities around this theme.

Photo 54: The Growth Sequence of a Pumpkin

The children began visiting their courtyard garden regularly, observing its natural changes over time. They became more familiar about pumpkins through Perri's read-alouds of informational picture books about the growth and change of fruiting plants. They represented their understanding of this process visually by cutting and pasting into their Lab Books photocopied pictures of plants at different growth stages in proper sequence (e.g., from seed to fruit).

Perri brought a pumpkin into the classroom and cut it in two so the students could examine the inside. Each child created a two-dimensional cut pumpkin, using yellow construction paper to represent the inside of the pumpkin, on to which they glued yarn and pumpkin seeds.



Changing Directions: Decomposition of Pumpkins

The children had engaged in a variety of well-organized, pre-planned activities about the growth of fruiting plants. However, Perri wanted the children's questions and ideas to chart the course of their learning, but did not know how to make that happen. She did not have to look far. The children, she would discover, were already one step ahead of her, with a question of their own.

Box 10:
Class Discussion

Perri: Who would like to share what they did over the weekend?
Student 1: I ate pumpkin pie!
Student 2: Me too! I went to the farm with my dad to pick a pumpkin. We ate pie too!
Student 3: We can make a pie with our pumpkin!
Perri: That's a good idea! I'll go over to the counter to get the pumpkin that we cut in half last week.
Student 2: Yuck! It doesn't smell good anymore!
Perri: Do you remember last week, when we first cut it open? Did it smell good then?
Student 3: What happened to it?
Student 4: It has brown and black spots!
Student 5: Why does it look like that?
Student 2: Because we didn't put it back together!

This is what happened: It was Monday and the kindergartens were gathered together on the carpet, sharing stories about their weekend. The conversation eventually shifted to a discussion about the cut pumpkin. The children had observed various changes that Perri had not even noticed: The pumpkin's shell was softer; there were dark spots inside it; and its seeds were beginning to rot. The children were curious about this mysterious transformation. They wanted to know: *"Why is the pumpkin like that?"*

This is what Perri had hoped for. To move forward, all she needed was to pay attention to what her students noticed and to go from there. Without Perri assuming the lead (or even noticing before the children had, that the pumpkin was changing), the students were shifting the direction of their inquiry. Perri's planned theme of a pumpkin harvest naturally morphed into a child-centred inquiry into decomposition. Perri was pleased to pursue this new direction with the children, as it still fit within the curriculum concept of growth and change. This experience set the precedent for a whole year of inquiry in Perri's class.

The next day, the children gathered in a Knowledge Building Circle to discuss their ideas of

decomposition and to describe what they currently noticed about their pumpkin. Perri recorded their ideas on a large sheet of chart paper, which she promptly displayed in the classroom to affirm the value of the children's contributions (See Photo 55)

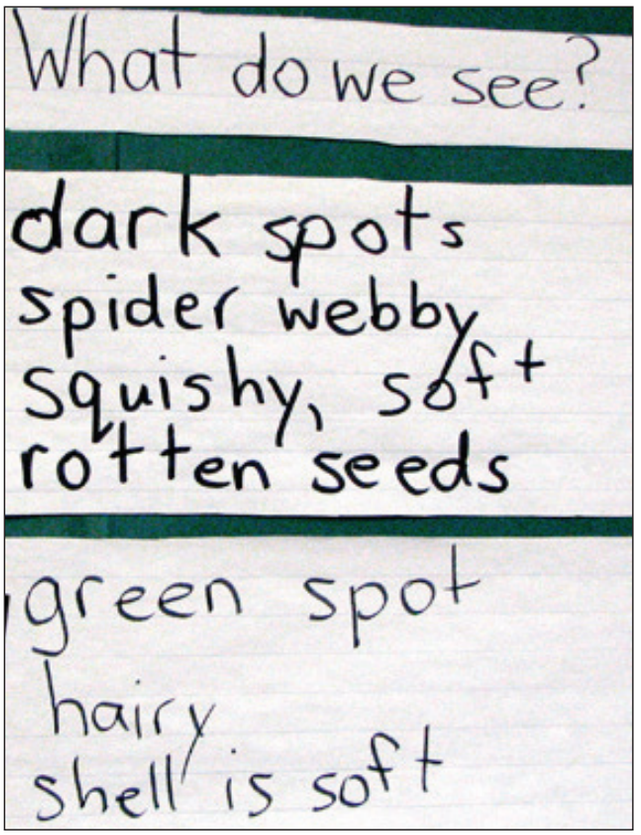


Photo 55: Students' Observations on Display

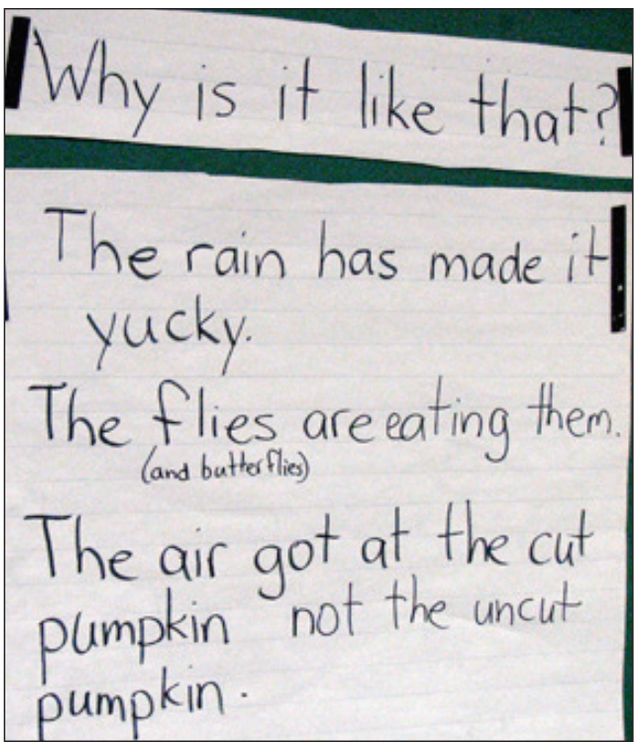


Photo 56: Students' Initial Explanations

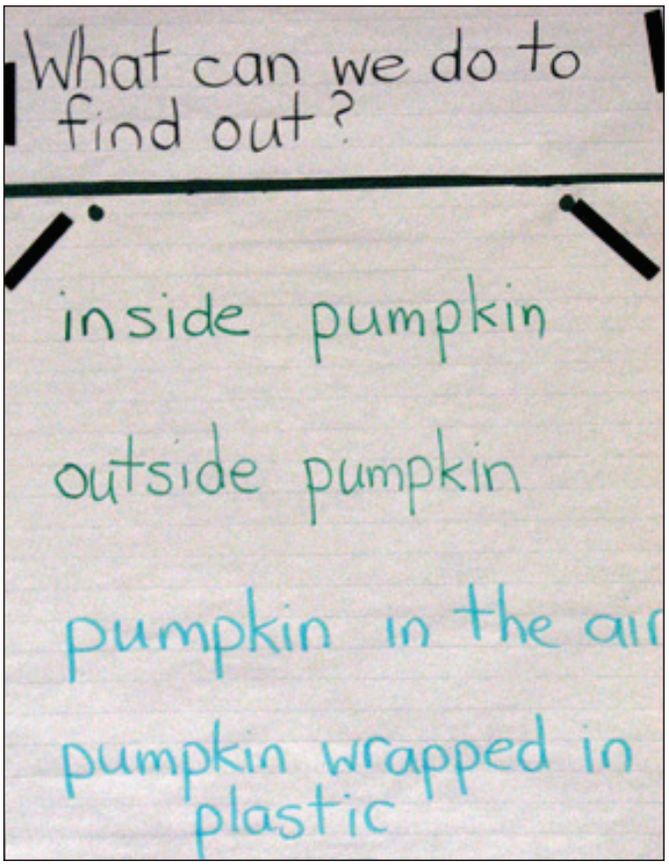


Photo 57: Students' Ideas for 'Finding Out'

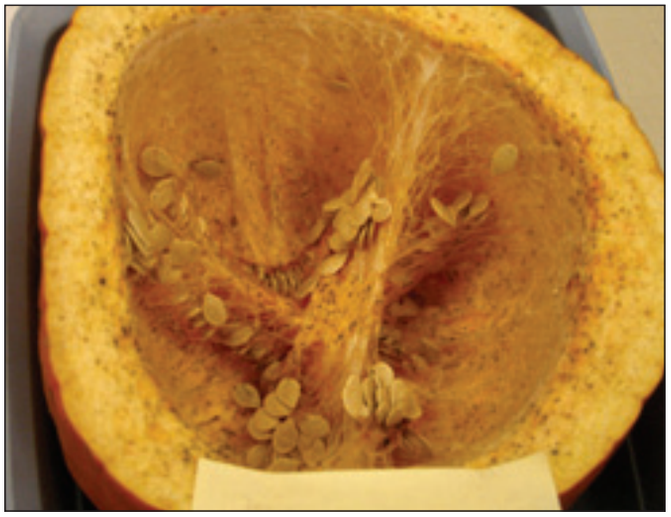
Experiential Learning

The next step, Perri reasoned, was for the children to investigate various ways to test their theories. She gently prompted them into design mode by asking open-ended questions such as: "What can we do to find out why the pumpkin looks the way it does? How can we test our theories? Where can we put our cut pumpkin to find out?"

The students decided to test out their ideas about weather and temperature by putting three cut pumpkins in different conditions: one pumpkin was kept outdoors; the other two pumpkins were kept in the classroom, one covered in plastic wrap, the other exposed to air. The children observed the changes in all three cut pumpkins, documented their observations in their Lab Books and came together as a whole class to contribute their individual observations.

The class predicted that the pumpkin wrapped in plastic would be the least rotten because it was less exposed to air. This prediction was based on

Outside Pumpkin



Inside Pumpkin (wrapped)

Outside Pumpkin (not wrapped)

their earlier theory that "the pumpkin was turning brown because the air got at the cut pumpkin, not the uncut pumpkin"(See Photo 56). After one week of observation, they discovered that the inside pumpkin with no plastic wrap had rotted the most, and the outside pumpkin had rotted the least.

Perri did not simply suggest to the children that they "were wrong" and that it was time to move on. Rather, she encouraged them to think about *why* the inside pumpkin that was left open to the air was decomposing more quickly. By positing their initial theory, and by observing, documenting and continuously contributing their individual ideas in Knowledge Building Circles, the class was able to come up with a refined theory: "The inside pumpkin rotted more because the air is dirty and hot. Outside air is fresh and cold". This collective approach to knowledge building led the children to gain a relatively accurate understanding of the effects of ambient temperature on the rate of decomposition (See Photo 59).

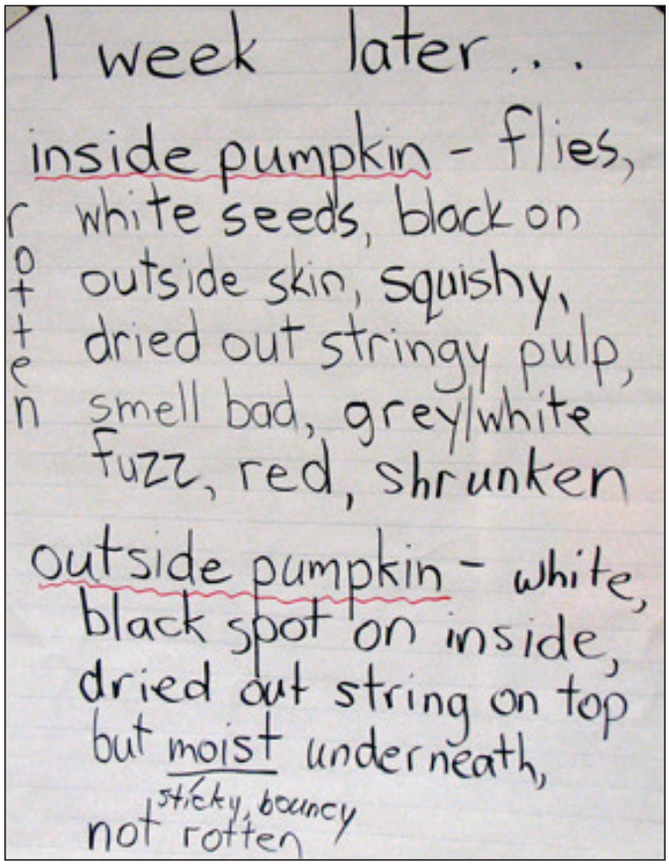


Photo 58: Decomposition Observations

The children were so attached to their pumpkin that

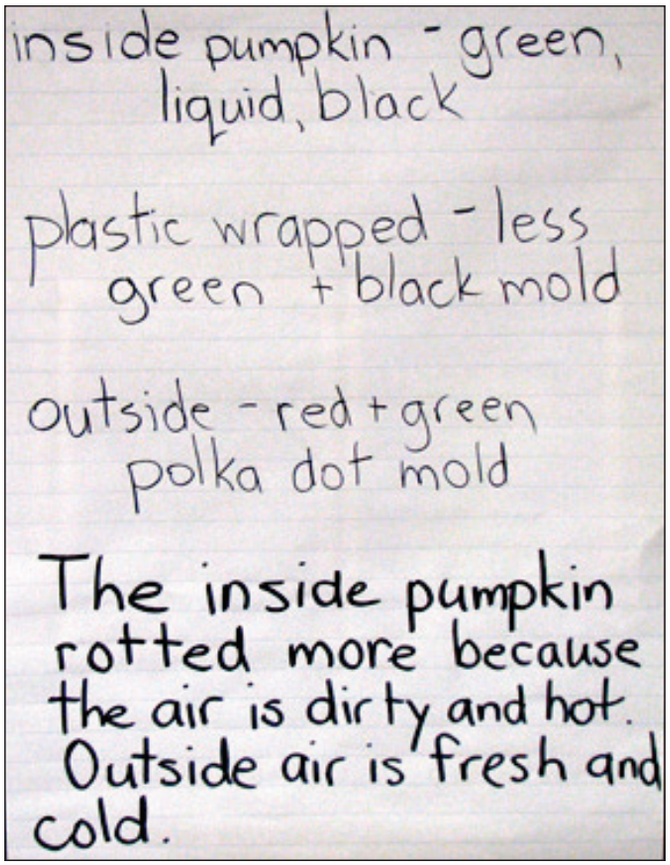


Photo 59: Collective Idea Improvement

they decided to continue watching it decompose for the rest of the year (or at least until it shriveled away). They placed the pumpkin in the courtyard garden, where they could observe it and other growing things from the classroom window whenever they wished. They visited the courtyard almost daily, making sketches, not only of the pumpkin, but also of the changes to the courtyard garden across the seasons. They became friendly with a Mallard duck who frequented the courtyard pond and eventually laid her eggs there. She became fondly known as Victoria.

Visits to an Urban Ravine

Perri was excited about the children's level of engagement with the inquiry into pumpkins. Eager to broaden their experience of the natural world, she initiated a monthly tradition of visiting a nearby urban ravine, where the children could immerse themselves in nature and observe the seasonal changes within this setting. These outdoor experiences provided opportunities that would enrich the children's learning.

During their first trek to the ravine, where Taylor-Massey Creek flows through Scarborough, East York, and into the Don River, Perri encouraged the kindergartens to explore everything. She asked them to look closely and ask questions. Perri paid careful attention to their comments and questions, and photographed the things that interested them for later use as memory prompts during class discussions.

Integrated Learning

Storytelling

Photo 60: An Autumn Walk in the Ravine

The class gathered on the carpet to share their experiences about the ravine excursion. Perri held up the photos she had taken and soon the children were reliving their experience at the ravine. They bounced with excitement as each photo helped them recall a particular moment and what it meant to them. Perri encouraged every child to contribute

what he or she remembered and furiously scribed their comments. Then she and the children decided on the sequencing of the photographs, based on the children's memory of the events. Perri compiled all the comments and photos into a book authored by the entire class.

When the children returned to the ravine in winter to investigate the changes brought on by the shifting season, they once again collectively told their story. However, the season was not the only thing that had changed. The children had grown and changed too! This time, not only were they able to recount their experience in the ravine orally, but they were also ready to convey their experiences in their very own handwriting! This gave Perri a chance to learn about her students' ability to make close observations of their surroundings while also assessing their early expressive writing and encoding skills. Perri sent this book home on a nightly basis for each of the students to share with their families. She was pleased to learn that some of her students returned to the ravine with their families after sharing this book with them.

Mapping the adventure

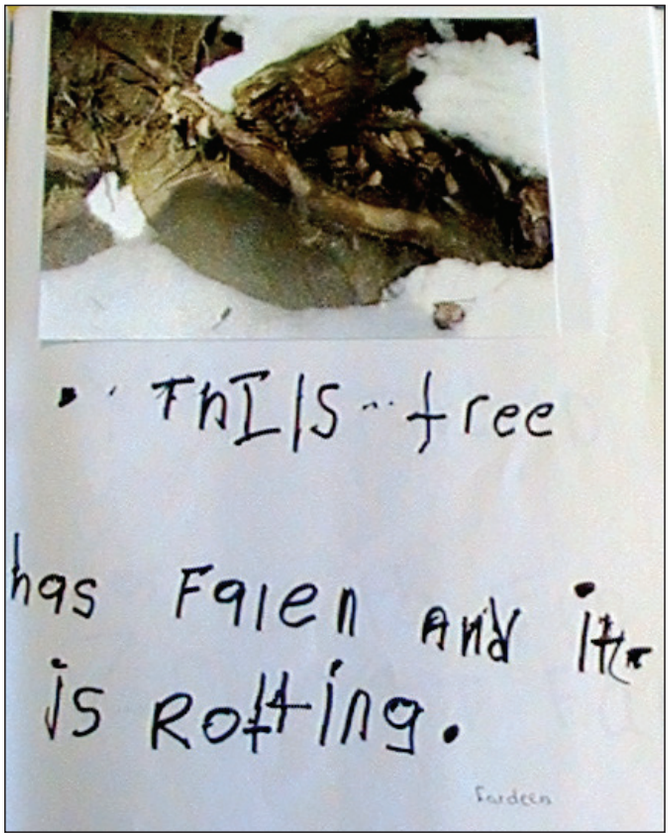


Photo 61: A Winter Walk in the Ravine

The class also recalled their walk to the ravine in artistic and geographic ways. Collaboratively, Perri and the students designed a map of their adventure by charting what they saw along the walking path: trees, leaves of different colours and the stream. Each child created a paper tree and contributed it to the class map. The class continued to recreate their ravine walk experience, as a texture mural, for each of the seasons.

Sobel (2008, p. 34) advocates this kind of local exploration and mapping: "Children have an inborn desire to explore local geographies. Developing a local sense of place leads organically to a bioregional sense of place and hopefully to biospheric consciousness".

Focus of Inquiry: Water Pollution & the Water Cycle

Starting a New Direction for Environmental Inquiry

During the children's visit to the ravine, a child asked a question that would spark a new direction for their inquiry. As this child was walking by a stream, he noticed plastic bottles and refuse in the water. He asked Perri, "What happens to garbage in water?" Perri's response was deliberately open-ended: "That sounds like something we should find out more about!"

Back at the classroom, Perri held a Knowledge Building Circle with her students. She asked the children to think of all the things they had observed

at the ravine and invited them to share their questions. The children had numerous questions, which Perri documented on chart paper. Many of the questions, Perri noticed, were related to water. Without her prompting, the question "What happens to garbage in the water?" had resurfaced, not from one child alone, but from many. And so, a new direction in the kindergarten's learning 'officially' began.

Experiential Learning

"What happens to garbage in the water?" When Perri asked the children to think of ways to answer this question, one student offered an idea for an experiment: "We can put garbage in water and watch what happens!" In response to this idea, the Kindergarten water table was transformed into an experimental water-pollution site (See Photo 62).

Photo 62: Water Pollution Experiment

For one week, the class threw their garbage in the water table and watched how quickly it changed. At the end of the week, Perri poured a cup of water from the tap and also drew a cup of from the polluted water table. She held both glasses of water side by side for the children to note the differences. They were revolted by the colour and the smell of the polluted water. Perri asked, "Would you like to drink the water that came from the water table? Would you like to swim in the water that came from the water table?" The children responded with a resounding "no!"

Through this simple, developmentally appropriate experiment, Perri was able to address, in a non-threatening way, the children's curiosity about the effects of pollution on water.

Revisiting the ravine in spring

The children would make connections between the effects of pollution on water and the consequences for wildlife. On their walk through the ravine in spring, they spotted a Mallard, whom they believed to be Victoria. Sadly, Victoria had vacated the courtyard after her ducklings had died soon after hatching. It did not take long before the children, once again, to notice a water bottle and other waste in the stream. They knew from Perri's Internet research that many ducks contract viral hepatitis from the toxins in plastic bottles in the waters, and that this disease can be passed from the mother duck to her young. An animal organization confirmed that Victoria's ducklings likely died because of these toxins.

The children's learning came full circle. The question they had asked back in October ("What happens when garbage is in the water?") was now answered. The children understood, through their experience in a real-life context, the links between human action, the quality of our waters, and the health of living things.

> *"I will never go back to teaching a traditionally prescribed unit that does not draw upon children's curiosity. I will always try to find a way to weave the expectations that the Ministry has into what the kids wonder about and want to know."*
> – Perri Evert, JK/SK teacher

Investigating Different Forms of Water

While it is always exciting for children to have a hand in designing experiments for their questions, it is also acceptable for the teacher to provide a science demonstration in response to a question that will lead to rich discourse and deeper thinking. Therefore, when the kindergartens were wondering about the origins and destinations of water, Perri set up a simple water cycle demonstration in the classroom that involved boiling water in a kettle

and watching the water evaporate into vapour. Perri then poured the boiling water into a glass jar to enable the children to see the condensation form on the inside (See Photo 63).

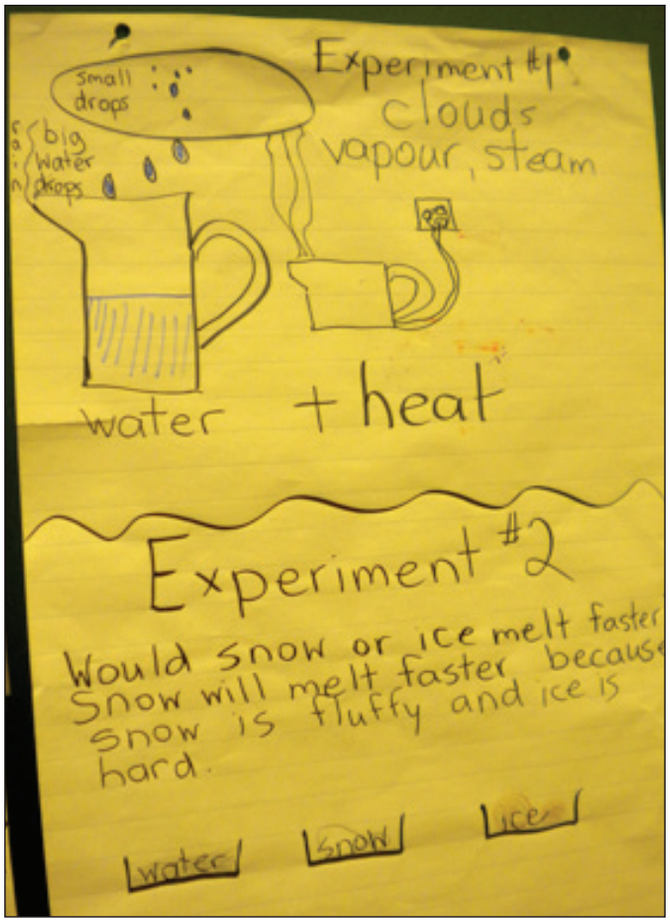


Photo 63: A Water Demonstration and Experiment

During the experiment the class discussed the different forms of water that they observed transform before their eyes. Perri asked the children to imagine what part of the experiment represented what they see in nature. The children identified the vapour as clouds, the water in the jug as a lake, and the water droplets on the side of the jar as raindrops.

From hearing Perri read aloud Thomas Locker's *Waterdance*, the children learned that snow and ice are forms of water. Locker's story, a stunning combination of images and poems, follows the journey of water from rain to river to lake to sea to cloud. Inspired to prove that snow and ice are forms of water, Perri and the children collaboratively designed an experiment that involved watching snow and ice melt into puddles and predicted which state would melt faster (See Photo 63).

The kindergartens then created a class mural to convey their understanding that water is omnipresent and can take different forms. Using various media, including construction paper, cotton balls, watercolours, and shredded paper, each child created a visual representation of water in a particular form and contributed to the class mural (see Photo 64). In a Knowledge Building Circle, the kindergartens then decided which label (vapour, water, ice, snow) should be assigned to each of the visual representations of water in its different forms.

Photo 64: Water is everywhere!

Perri's Final Word

"In September, I could not have predicted that all of these events would occur. All I knew ahead of time was that I wanted the children to explore the concept of growth and change in the environment, that I wanted them to immerse themselves in the natural world, and that I wanted to spark and follow the direction of their curiosity.

I'm a lot happier teaching this way. Doing it through the questioning and the ideas that the kids have, just covers so much in a deep way. We meet more curriculum expectations this way than if I were teaching solely in a more traditional teacher-directed way."

Key Concepts: Patterns in Waste Production, Waste Minimization, Impact of Landfills on Environment

Subject Areas & Skill Sets: Mathematics (Patterning & Algebra, Data Management), Language (Oral Communication, Reading, Writing, Media Literacy), Research Skills, Arts

Focus of Inquiry: Waste Production in the School

Victoria Village Public School

Grade 4: Vessna's Story

Vessna had only a few years of teaching experience at the elementary level (Grades 2 through 4) when she began her Inquiry journey. Although enthusiastic and open to new ideas and ways of teaching, she admits to feeling "hesitant" at the beginning: her grade team members were not starting Inquiry with her; she was concerned about her ability to cover all the curriculum with this new teaching approach; she had not prepared complete units to serve as 'back-up'; and she was uncertain about whether her students "were going to learn enough content and would have enough time for everything".

Looking back at her year of Inquiry, however, Vessna is happy about the quality of her students' learning and their attitudes about themselves. "They learned to understand their own thinking processes. They felt empowered that they had made a difference in the world and in their school community."

Focus of Inquiry: Waste Production in the School

Starting the Environmental Inquiry Process

Vessna did not set out to begin an inquiry into patterns in waste production. Rather, this direction evolved from an informal snack-time conversation among the students. It eventually became the focus of Vessna's unit on patterning and algebra.

Here is what transpired: Vessna began the unit in her usual way, working from the Mathematics textbook that is widely used throughout her school district. She asked her students to follow the examples of patterning and algebra in their textbooks and to complete a particular list of problems. The students were accustomed to this approach. They routinely completed their assigned work and were able to identify increasing and decreasing number patterns.

However, Vessna was not satisfied. She wanted her students to understand the concept of patterning in a larger context, using real-world problems that would capture their interest. For this reason, when it came time for the Grade 4s to learn about T-tables, Vessna paid close attention to her students' conversations to find out what they were curious about. She wanted to channel their specific

Box 11:
Knowledge Building Circle:
"How much garbage do we send to the landfill?"

Student 1: If 22 Students each ate two bags of Crispy Delights, then how many packages of Crispy Delights will go to the landfill?
Student 2: We counted by twos in column two and got to 42.
Student 1: That's too much garbage!
Student 2: Our other question was: If one student eats two Crispy Delights per day, then how many wrappers will go in the landfill after 31 days?
Student 1: We counted by twos again and got 62 Crispy Delights.
Student 1: We learned that that would create way too much garbage, because we only measured just this one class.
Student 3: Yeah! Imagine if everyone in the whole school had two Crispy Delights per day. How much would go to the landfill?
Student 4: Imagine how much garbage altogether the school sends to the landfill!
Multiple students: Let's find out!

interests into the classroom learning.

However, it was during their in-class snack time, when the students commented on the fact that many of the children in the class had 'Bear Paw' cookies for a snack, that Vessna picked up her first clue. One child peered into the garbage bin, exclaiming, "Look how many Bear Paw wrappers are in the garbage!" Another child was also clearly shocked: "Whoah! How many are in there?"

Vessna moved in quickly, taking the children's observations as her cue. "Where do you think they will all go?" she asked. "The landfill dump!" offered a student. One question led to another: "How many wrappers does our class send to the landfill? How much garbage do we send to the landfill?" This conversation sparked the class' Environmental Inquiry into the patterns of waste production.

It is so easy for the learning potential of this type of informal exchange to be overlooked or disregarded. Clearly, however, informal discussions that are sparked by genuine curiosity can serve to motivate students to explore new learning opportunities. In this case, the snack-time conversation presented the kind of real-world application for T-tables that Vessna had been waiting for, especially because of its connection to the environment.

"How many wrappers does our class send to the landfill? How much garbage do we send to the landfill?" Vessna seized upon the issue of waste production as the context for a Math unit on patterns. This time, however, the children designed their own problems based on the different packaging that ended up in the waste bin each day, instead of relying solely on the predetermined math problems presented in their textbook (See Photo 65, and Box 11).

As Vessna discovered, an essential aspect of the inquiry process is Knowledge Building Discourse, a time reserved for the children to come together as class to share how they solve particular issues, communicate problems of understanding or to pose new questions. It was precisely during this time, when the class was discussing their T-tables, that the larger question "How much garbage does our whole school send to the landfill?" became the focus of a collaborative investigation involving the entire class.

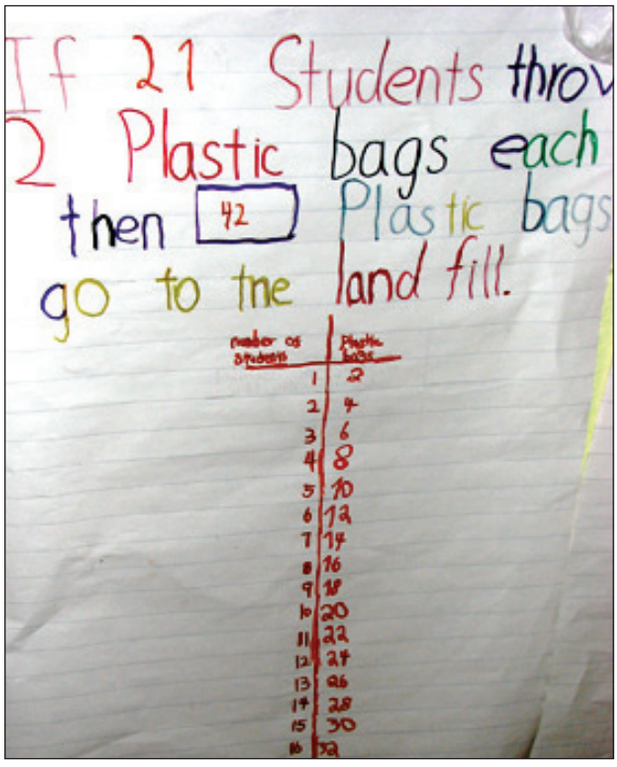


Photo 65: Student Generated T-table Problems

Experiential Learning

The Grade 4s' School-Wide Waste Audit

Photo 66: Sorting the School's Waste

Vessna's Grade 4 class wanted to know how much garbage their school was sending to the landfill and whether the students and teachers were making environmentally conscious and responsible decisions about the waste they produced daily. To investigate these questions, the class carried out a school-wide waste audit. With approximately 350 students, plus the teaching and support staff, this was a huge undertaking. Vessna had never done anything like this before. Where would she begin?

Vessna was confident that the children would have valuable ideas to contribute to this process and she wanted to empower them. So instead of agonizing about how she, alone, would tackle this project, she turned it over to the students, allowing them to take the lead in the planning and implementation of the audit. "How are we going to do this?" she asked the students. "Where do we begin?"

The children had many initial ideas, which they would later refine, including:

- "We should survey each class to see who drinks or eats things that produce garbage."
- "We should break up into groups that look into different types of garbage: recycling, garbage, compost."
- "When do we have the time to prepare for all this?"
- "We should ask classes to collect garbage over three days".
- "We should go to classes beforehand to let them know what we are doing, and how to collect the garbage."
- "We should include the kindergarten class too, and the staff rooms!"
- "We should talk to garbage workers and ask how much garbage per day is produced for disposal in a landfill."

Through discussion and negotiation, the students revised their initial ideas and agreed upon the following principles:

- The planning and implementation of the audit should take place during math time because their initiative was inspired by a math class and was mathematical in nature.
- The garbage should be collected from each classroom over a one day period instead of three to provide a sense of the daily amount of school garbage that was going to the landfill.
- The waste audit should be a surprise spot-check for all the classes. As one student realized, "If the classes know that we are coming, then they are going to plan to reduce their garbage on purpose".
- The required materials for the audit should include: garbage bags, plastic bins for sorting, gloves, mops, labels for the sorted bags, and paper for recording information about each class.

For an entire afternoon, the children sorted through the garbage bins in each classroom and learned important information about each class' waste production (For details, see Table 17 on page 117). The students collaborated on every stage of this process: from project design and set-up to garbage collection, sorting, documenting, and cleanup.

Observing compostable waste in action

Photo 67: Compost at Forest Valley

In the midst of the waste audit, the Grade 4s were surprised to discover that their school was producing a large volume of potential compost everyday and sending it to the landfill. This discovery left a lasting impression upon them. Surely there was a better option.

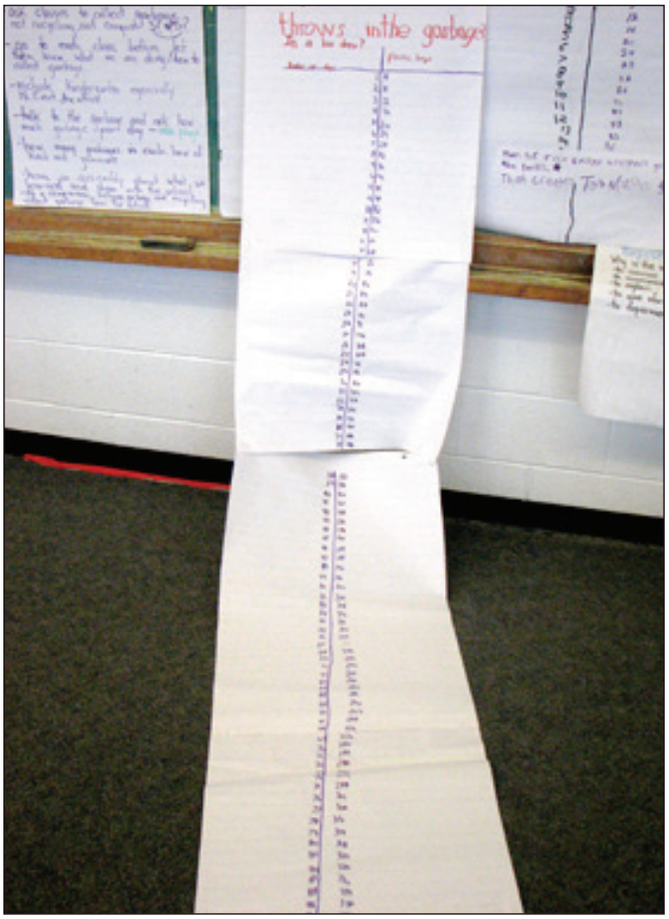
Therefore, when the students visited the Forest Valley Outdoor Education Centre several months later, they jumped at the opportunity to observe the process of diverting organic material into compost. As the Forest Valley staff turned a massive mound of compost, they learned that our planet renews itself through this same natural process of organic decomposition (See Photo 67). To their dismay, they now understood that the piles of organic waste produced daily at their school were doing nothing more than increasing the accumulation of waste in the landfill that received them.

This level of understanding did not come from a page in the students' math textbook. It came from a deeper source: the student's own questions and their desire to answer them. For Vessna, this experience affirmed that lasting learning experiences are more likely to occur when students' questions are at the centre of their learning.

> *"The reason that I like Inquiry is because it allows students to just take it wherever they can according to their intellectual capabilities, because they start from where they are."*
> – Vessna Romero, Grade 4 teacher

Integrated Learning

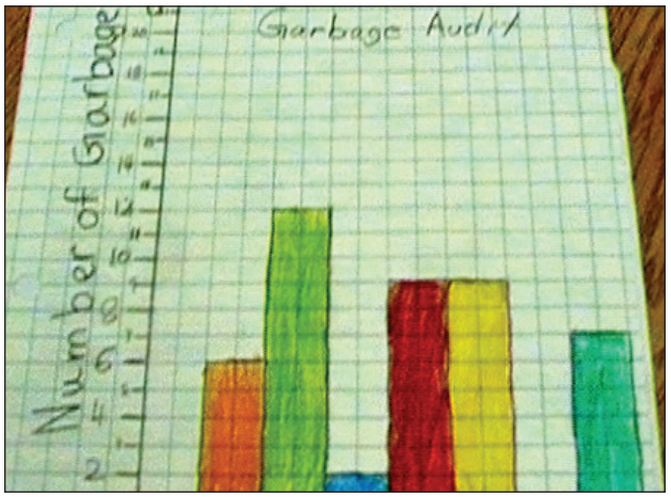
Data collection and management

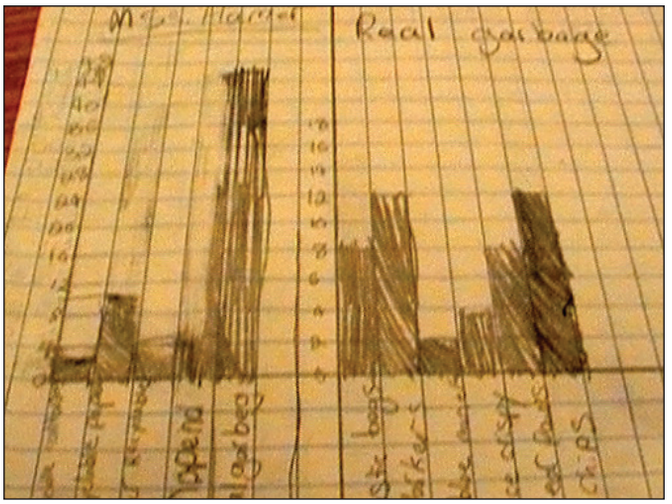


To make sense of their waste management audit findings and to represent them in a meaningful way, Vessna's students needed to learn specific skills related to data collection and management. Without these essential skills, their Experiential Learning would have been nothing more than an exercise in classroom garbage collection!

The students needed to make decisions about how to sort and separate the different types of waste. They negotiated and agreed upon the following categories: recyclable paper, recyclable containers, reusable materials, compost, and real garbage (waste that cannot be recycled, reused or composted). Within the category of real garbage, they added a sub-category, snack packaging (including the Bear Paws wrappings!). The students were surprised to find several unopened containers of food and created another category: unopened food packages. They created a Waste Audit Record sheet that listed all of these categories on which to record their findings.

The Grade 4s counted the number of individual items in each of these categories, except for the compostable waste, which they chose to weigh instead. Counting it was considered too difficult and "gross". Working in small groups, they sorted and separated each class' waste and recorded their findings on their Waste Audit Record sheets.





Vessna saw an opportunity for the children to learn about graphing in a meaningful context, using their own data from an audit they had designed and implemented, and representing it as they saw fit. Some students created graphs that represented each of the larger categories, while others focused on the breakdown of the "real garbage" category. A few students created two different graphs because they thought it was important to illustrate both sets of findings.

However, the Grade 4s encountered a problem: how to represent the "compost" category. The other categories were measured by the number of units, but compost was measured by weight. The students did not want to exclude this category from their graphs because it represented a large proportion of school garbage that went to the landfill. In fact, they had vivid recollections of being overwhelmed by the enormity of compostable waste. The Grade 4s found a solution. They created one large graph depicting the compostable waste found in each classroom (See Photo 68). The Y-axis indicated weight in pounds, while each of the classes were represented along the X-axis.

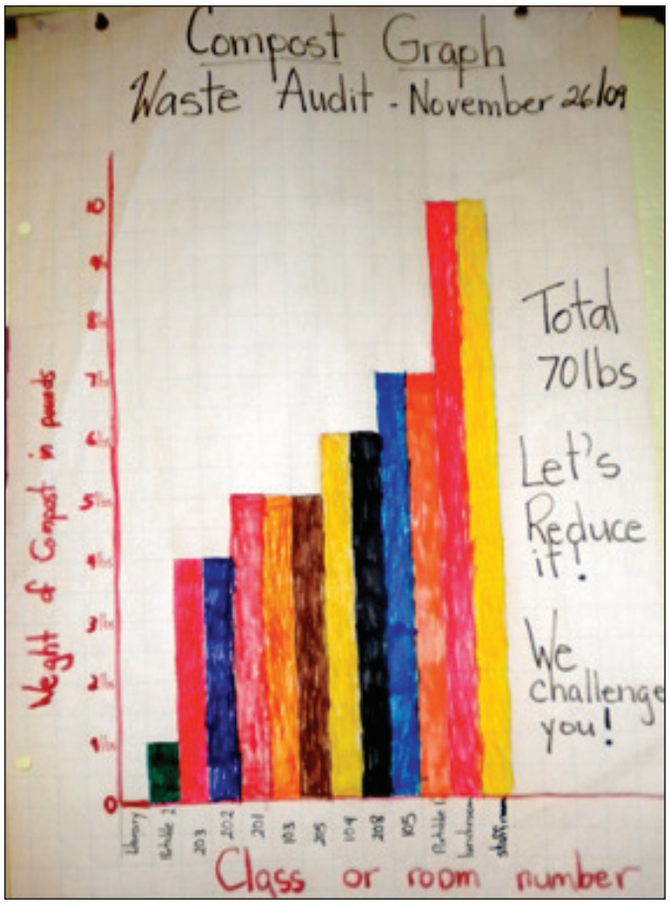


Photo 68: Consolidated Data of the Whole School's Compost

The students analyzed their own and each other's graphs to determine whether the classes were managing their waste effectively. They found that a substantial amount of recyclable materials were ending up in the school's garbage bins instead of being deposited in recycle bins. All those recyclables were needlessly being sent to a landfill. Similarly, compostable waste also accounted for a significant proportion of school waste.

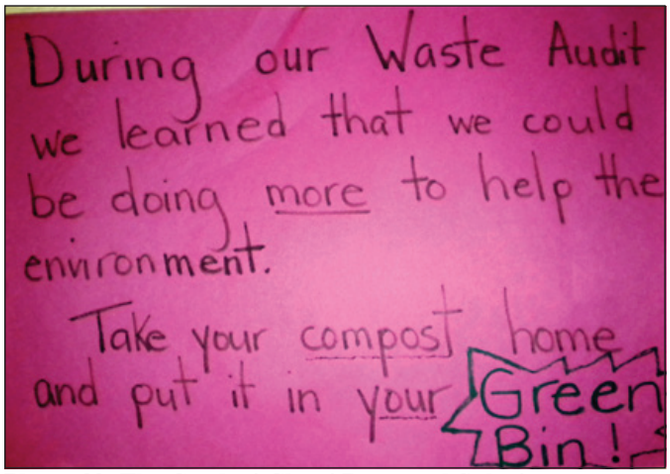


Photo 69: The Grade 4 Class' Proposed Solution

> *"I think I've changed in that I feel now the need to ask kids what their questions are about the world. I was getting a little tired of fill-in-the-blanks. I was getting tired of finish the sentence. I was getting tired of handing out photocopies. In fact, I haven't made photocopies in a while… It's true!"*
> – Vessna Romero, Grade 4 teacher

Turning waste into art

The waste audit opened the students' eyes to the amount of garbage that was being sent to the landfill, including waste that could be recycled, and even more importantly, reused or repurposed in some way. In partnership with a student from the Ontario College of Art and Design (OCAD), Vessna and the Grade 4s took on a project to beautify the school courtyard, creating sculptures from the school's recyclable waste.

Stewardship

Photo 70: The School-wide Assembly

The Grade 4s knew a lot about their school's waste production and management practices and felt a responsibility to share it with the other students and teachers. To increase awareness, they decided to hold a Waste Awareness Campaign at their school-wide assembly.

As a first step in communicating their message, the Grade 4s collaboratively selected what they considered were the most compelling quantitative and qualitative findings from the waste-audit data. Clearly, the students and teachers needed to know that most of the school garbage that was being sent daily to the landfill consisted of compostable organic waste and recyclable materials. This was shocking news!

The Grade 4s wanted the staff and students to know why it was important for each class to re-think the manner in which they produce and manage waste. They decided to complement their findings with research about the environmental impacts of both organic and non-organic waste that end up in landfills. This would make for a more compelling message.

The students also considered how best to make their information accessible to their audience, which consisted of children ranging from JK to the junior years, as well as adults. They decided to share their message in a variety of ways, beginning with a brief dramatic skit about waste production indifference, followed by video footage of the Waste Audit Day to illustrate how they had arrived at their results. Additionally, each of Vessna's students presented a brief finding or fact about garbage production (See Table 17). The Grade 4s wanted everyone in the class to have an opportunity to present, to make the presentation more dynamic. All these strategies served to fulfil the curriculum goals of media literacy.

Table 17: Excerpts from the Grade 4 Waste Awareness Assembly

"The garbage that is taken away by the garbage truck is taken to a place called a "landfill". It is a place outdoors where garbage is dumped into a big huge pile. The pile will sit there, and all the juices from the food, vegetables, old batteries, plastics, and everything we throw out gets mixed up together and goes to the bottom of the ground. Then the ground soaks it all up. The mix of juices is poisonous for all things that live on Earth: animals, plants, and us. "
"A Bear Paw package takes 20 to 30 years to break down. Plastic baggies are not recyclable, so ask your parents to use reusable containers for your lunch and snacks. It also takes 20 to 30 years for plastic baggies to break down."
"Things that are recycled are made into something else. They make used paper into recycled paper instead of cutting down more trees, and make clothes out of recycled plastics. Things that go in the compost help make better soil for the plants to grow, so take your compost home and put it in your green bin."
"We also saw unopened food packages. Things that absolutely have to go to the garbage go to the landfill, but let's try to make the pile smaller and smaller by not putting recyclables, compost, or unopened food in there."

The Grade 4s challenged each class to think of strategies to better manage the waste in their classrooms and to prevent it from entering the landfill. Their presentation ended with a representative of the class calling for change:

> "We challenge you to help save our Earth and make it healthy. We will be giving each class a paper organizer. You can do your part with your class by making a list of things that you should be putting in your recycling bin, as well as things that you could compost or reuse."

The Grade 4s enjoyed taking on a leadership role in their school and felt empowered to make a difference. To ensure that their message resonated long after the assembly was over, they launched a school-wide Waste Awareness Campaign that consisted of posters displayed throughout the school and advertisements for the morning announcements.

The Grade 4s' commitment to reduce waste production in the school was pervasive, crossing subject, classroom, and even time-related boundaries. By April, the students still felt a sense of ownership for their waste reduction initiative. In preparation for Earth Day, the Grade 4s launched a Garbage Reduction Contest for the whole school. The winner would be the class that produced the least amount of garbage for three days. The winning class would then share their strategies with the entire school by compiling a list of items that they recycled, reused, threw in the garbage, and brought home for composting. Once again, the Grade 4s organized all of the advertising for the contest. They displayed posters throughout the school, provided daily announcements, and selected the winning prize.

The Grade 4s' waste audit continued to inspire Vessna's students. They remained committed to their goal of minimizing waste over the entire school year. Clearly, this remarkable learning experience came about because their curiosity was valued from the outset and their sense of agency was fostered. They designed their waste audit. They uncovered compelling findings. They demonstrated leadership in the school community. Such was the power of Environmental Inquiry in practice.

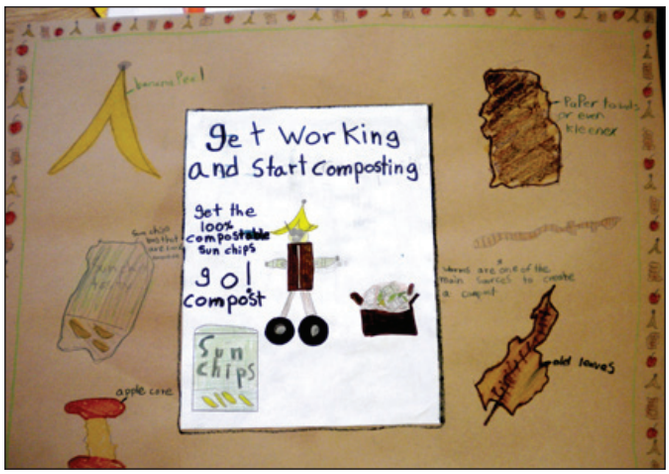


Photo 71: A Waste Awareness Poster

Vessna's Final Word

"I've seen my students flourish in that they want to find the information; they're hungry for information because it's something they want to know. As I reflect on my year of Inquiry with the Grade 4s, I realize that each of my students went through their own educational journey.

I see my former students now and they tell me they wish they could go back to last year because they learned so much. And I tell them that I did too, and that I want to do Environmental Inquiry as long as I am teaching."

Key Concepts: Water, Growth and Change

Subject & Skill Areas: Personal and Social Development, Science, Language (Oral Language, Reading, Writing), Arts

Focus of Inquiries: Evaporation and Capillary Action, Life Cycle of Butterflies

The Grove Community School

About The Grove Community School: A new alternative school in the west end of Toronto with a joint emphasis on ecological sustainability and social justice. Students are from diverse racial, linguistic/ethno-cultural, and socio-economic backgrounds.

Grades JK/SK: Amanda's Story

Amanda had taught for three years, all of them in Kindergarten, before joining The Grove Community School where she began her journey into Environmental Inquiry. She had what she describes as "extremely active and inquisitive" kindergartens with a "wide range of learning needs".

Amanda was both excited and nervous about beginning Environmental Inquiry. She knew that young children learn best when they "are in the moment" and "physically involved" in their learning. But she was unsure about the planning process. How would she keep her planning responsive to her students' interests, especially if they evolved or changed direction?

"But I trusted my students," Amanda recalls, "and I wanted us to learn together. I think it's really about being comfortable and trusting the children. That's what helped me move forward, just trusting that they're going to take it somewhere meaningful. And they did!"

Key Concept: Water, Growth and Change

Starting the Environmental Inquiry Process

Photo 72: The Classroom in the Courtyard

Amanda was eager for her students to spend time in the school's courtyard, which had grown beautifully wild over the summer months. As an Early Years educator, she knew that children learn best through play and that they have a strong preference to play in natural outdoor spaces. With this in mind, she sent the kindergartens into the courtyard early in the year, where they played, leaped about, and explored. They fondly referred to this space as the Classroom in the Courtyard.

The courtyard provided an ideal setting for Inquiry, an opportunity for the children to develop a relationship with nature, even at this relatively small scale. Amanda wanted her students to make discoveries, ask questions, and give full reign to their natural curiosity. Thus, when Amanda brought her students out to the Classroom in the Courtyard one day in early fall, she gave them a simple, open-ended instruction: "Look carefully at the nature all around you and draw a picture of what you notice. It can be big or small – anything that captures your attention".

"The Knowledge Building Circles are new for me. I taught in an inquiry-based way previously, but I never thought of asking the children for their own theories as a place for them to start, and then let them participate in deciding how we were going to figure out the solutions."
– Amanda Tustin, JK / SK teacher

Each child was given a blank Inquiry Lab Book, which they would use to make their drawings of the courtyard, not only on this day, but throughout the year. The children would use these drawings in Knowledge Building Circles as visual reminders of what they had observed about the courtyard on a given day. As the children wandered about, making sketches of whatever captured their interest, Amanda noticed that they seemed more focused than usual, "more mindful" of specific aspects of the courtyard. They were "looking for things" and became excited when they discovered something new. Amanda's simple instruction "to look carefully" had intensified the children's level of engagement with their surroundings.

Photo 73: Kindergartens in a KB Circle

The children then gathered in the classroom for their first Knowledge Building Circle (See Box 12). Amanda asked the students to think about their most recent experience in the courtyard: "What did you notice today in the Classroom in the Courtyard?" As the children shared their observations (See Table 18), Amanda made sure to scribe them. She perused the list for common themes and interests. The children were particularly interested in the fact that the water under the bridge had disappeared. Amanda took this as her cue to probe deeper: "What do you wonder about what you noticed?" The children offered numerous "wonderings" (See Table 18), affirming to Amanda their interest in this 'mystery'.

Table 18: What the Kindergartens' Notice and Wonder

What we NOTICE about the classroom in the courtyard	What we WONDER about the classroom in the courtyard
"I noticed a tree that kind of looked like a Y."	
"I noticed some worms under a rock."	"I wonder where the water went."
"I noticed that there was no water under the bridge!"	"I wonder if the water turned the soil into mud."
"I noticed trees, flowers, worms, grass, and dirt."	"I wonder if all the water went up in a cloud."
"I noticed that there was no water under the bridge too!" "Maybe it's because it didn't rain today."	"I wonder if the water was turning to ice."
"I noticed that there was no water, too! Maybe the water dried up!"	

The students and Amanda were new to the idea of investigating their own questions in greater depth. Amanda decided it would be best, at this early stage, for the children to explore together one general question: "I wonder where the water went?"

Documenting children's thinking processes

To validate her students' thinking processes, Amanda displayed the children's questions, ideas, and investigative strategies on the classroom wall, organizing them according to the Ministry's guidelines for play-based learning/learning through Inquiry (See Table 19). She was pleased to see the striking parallels between her students' thinking processes and the Ministry's guidelines.

Box 12:
Knowledge Building Circle:
"I wonder where the water went?"

Student 1: Little bugs sucked up the water.
Student 2: All the plants drank it up!
Student 3: I kind of agree with [Student 1] because tiny drops of water do get into the air.
Student 4: Maybe a camel drank it up!
Student 5: I think the birds sucked it up.
Student 6: Maybe the water went through the sides.
Student 7: Maybe the worms drank it up.

Table 19: Ministry Guidelines and Amanda's Experience of Environmental Inquiry

Ministry Guideline: The Inquiry Process in Early Learning – Kindergarten Classrooms*	Amanda's Experience of Environmental Inquiry
INITIAL ENGAGEMENT	**Children's initial questions**: During their first few experiences in the 'Classroom in the Courtyard,' the children were encouraged to wonder out loud and to share what they noticed about the natural surroundings. Amanda collected, documented, and displayed these initial observations and questions on the classroom wall under the category "Initial Engagement".
EXPLORATION	**Children's initial theories**: Through ongoing exploration of the outdoor "Classroom in the Courtyard," the students made more closely focused observations related to their initial queries. They posited theories and even asked new questions. Amanda collected, documented, and displayed these initial theories and questions on the classroom wall under the category "Exploration".
INVESTIGATION	**Children's ideas for finding out**: Amanda encouraged her students to collaboratively think of ways to test their theories. How would they start? What would they need? What would they be looking for? She collected, documented, and displayed the students' investigative strategies on the classroom wall under the category "Investigation".
COMMUNICATION	**Children's findings**: Through individual observation and frequent Knowledge Building Discourse, the children shared their findings, ideas, and unresolved questions with each other (with Amanda's facilitation). Amanda displayed the children's findings on the classroom wall under the category "Communication".

*Source: Ontario Ministry of Education, *The Full-Day Early Learning – Kindergarten Program 2010-2011*, Draft Version, p. 15.

"You have to do a lot of planning but you have to be willing to let go of plans if the children take it in a different direction."
– Amanda Tustin, Kindergarten teacher

Experiential Learning

Amanda encouraged the kindergartens to visit the courtyard regularly to investigate the mysterious disappearance of water from under the bridge and to gain experience in positing their theories prior to collaborating on possible solutions. She found that the children's ideas evolved with each visit (See Boxes 12 and 13) and that most of their ideas related to the notion of evaporation.

Box 13:
Knowledge Building Circle:
"I wonder where the water went?"

Student 1: I think that the water went to the sea, so there is never going to be water there anymore unless it rains."
Student 2: My theory is maybe the water went to the little river.
Student 3: My theory is that the water dried up. EVAPORATION
Student 4: My theory is the water went to a different bridge.
Student 5: These markers are drying up in the same way and for the same reason that the water dried up. EVAPORATION
Student 6: The water went out through the roots, and went lower, lower, lower, and then shooted up into the sky. EVAPORATION
Student 7: I disagree. I think it is impossible for it to shoot up into the sky. EVAPORATION
Student 8: How did the water shoot up into the sky? EVAPORATION
Student 9: I wonder how the water shot back up into the sky? EVAPORATION
Student 10: There's a tube in the soil that is sucking up all the water into a cloud. EVAPORATION

One student posited the following explanation: "The water went out through the roots, and went lower, lower, lower, and then shooted up into the sky". Although this idea was met with some scepticism, it served to channel the children's thinking about the manner in which evaporation occurs. By sharing and negotiating their ideas, the children were able to define the scope of their query. Not only were they interested in where the water had gone, they also wanted to know how it got there. Did the water "shoot up into the sky?" If so, how?

Pursuing questions and investigating theories

"Where did the water go? How does it shoot back up into the sky?" Amanda encouraged the students to consider how they would go about investigating these two questions: "What can we do to find out if our theories are true?"

One child was quite attached to her idea that soil contains invisible tubes that "suck up" water all the way to the clouds and wanted to test this idea, using the following experimental design: "We can put some water in a container with a lid on it. We could stick a tube through the lid and see if the water disappears" (See Photo 74). Amanda provided the required materials and encouraged the children to think more about the design. "How will we be able to tell if the water is disappearing?" At the children's suggestion, Amanda drew a line on the container to indicate the current water level. And so, a student-designed experiment in evaporation began.

Photo 74: A Student-designed Experiment

The students made sketches of the experiment in their Inquiry Lab Books. Although they visited the experiment regularly to observe any changes, it seemed as if nothing was happening. The days passed and the children noted that "it was taking a really long time for the water to disappear". In fact, several weeks passed before they saw even a slight drop in the water level (below the "Day 1" mark on the container). By then, large water droplets were forming inside the tube. What did this mean? That water actually moves up "tubes"? And if so, through which ones? It was all a bit confusing.

> *"The fact that they're going home, using the language that we're using at school at home, shows that they have changed. Even the siblings who come in have been using 'My theory is… Look, mom, my water's going down my cup. My theory is it's going down because I'm drinking it.'"*
> – Amanda Tustin, JK/SK teacher

Students sometimes reach an impasse in their understanding. Their efforts to solve problems collectively can be stymied by diverging ideas and lack of focus. In such cases, teachers can introduce an intervention, such as a demonstration, that could help move the children forward. Amanda realized that her students had reached such an impasse. To help them get 'unstuck,' she brought celery sticks to the next Knowledge Building Circle and opened the conversation with the following remarks:

> "We have been wondering if tubes have anything to do with the way that water gets back into the sky, or evaporates. I have brought in some celery because I noticed something about it the other day that I wonder if you will notice too. Look closely at the bottom and along the sides of the celery. What do you see? I will pass it around the circle so everyone will have a chance to look."

The children quickly understood the significance of what they were looking at: "Holes! Long tubes!" Amanda passed around a magnifying glass so that they could examine the "tubes" more closely and asked open-ended questions that would encourage the children to think of this demonstration as their own: "I wonder what will happen if we put this celery in water. Do you think the water will go up the tubes?" To this, the children had mixed responses. There was general confusion about what would happen. Once again, Amanda encouraged them to think strategically: "Wait a minute. Water is clear. How can we make sure that we can see if the water is actually going up the celery tubes or if it is just evaporating into the air around the celery?"

Photo 75: The Celery Demonstration

The children were catching on. "Make it a different colour!" At their suggestion, Amanda added red food colouring to one jar of water, blue food colouring to the other, and placed two stalks of celery in each jar. The children regularly visited the celery experiment, documenting their observations (by making drawings and labelling them) in their Inquiry Lab Books. They were amazed by the gradual change in colour of the celery stalks and leaves and, on the basis of their observations, made the following generalization: "Celery sucks water up through its tubes". In a concrete way, the children were observing the process of capillary action!

Photo 76: A JK Student's Celery Observation

Extrapolating knowledge

Amanda wanted to know whether the children would transfer that understanding to other types of plants. She gathered them in a Knowledge Building Circle for another inquiry into "tubes". In the centre of the circle was a vase of red-coloured water. Amanda held three daisies up for the children to see, while she asked them to share their observations about the celery experiment. The children described the effects of blue water and red water on the celery stalks. Then Amanda turned their attention to the daisies: "What might happen if we put these white daisies in the vase with the red-coloured water?"

Although their individual responses revealed nuanced differences in ability, in general, the students were able to transfer what they had learned from the celery demonstration to a different plant form:

"I think the flowers will turn red and the water will turn white."
"I think the flowers will turn red and the water will stay the same."
"I think the green part of the flower and the white flower will turn red."

Photo 77: The Daisy Demonstration

Amanda placed the daisies in the vase of red-coloured water. The students were amazed to see the change of colour in the daisies. Although they could not observe water absorption in trees, the celery and daisy demonstrations were evidence enough that the same principle was at work.

Moreover, the two demonstrations showed that there can be more than one answer to a question. The water under the bridge could have "disappeared" because of two contributing factors: evaporation, and the capillary action of roots.

Focus of Inquiry: Life Cycle of Butterflies

Starting the Environment Inquiry Process

Amanda wanted her students to experience other natural settings in addition to the courtyard. To do this, she began an Environmental Inquiry into the growth and change of insects. The process began with a field trip to the Kortright Conservation Centre in Woodbridge, Ontario. The children attended a presentation on insects, which they found fascinating. Amanda paid close attention to their comments and responses, noting that they seemed particularly interested in caterpillars. They learned a song about the life cycle of butterflies and sang it repeatedly on the ride back to school.

Amanda wanted the children to build on their knowledge of insects, this time by exploring an outdoor setting they knew well: the Classroom in the Courtyard. Off they went with their Inquiry Lab books and Amanda's instruction to find as many different insects as possible in the courtyard. The children used popsicle sticks and magnifying glasses to aid in their search as they poked under plants and dug in the dirt. They documented their findings in the Lab Books by drawing pictures of the insects and labelling them.

Amanda felt confident that the children were ready to share their questions about caterpillars and butterflies and to investigate them in different ways. Thus, she ordered a supply of caterpillars to the classroom. From this point on, the children's primary mode of inquiry was to observe the caterpillars daily, watching closely as the process of metamorphosis took place, and noting even the smallest changes in their Inquiry Lab Books. They shared their observations about these changes during Knowledge Building Circles, consulted books and authoritative sources together, and attended a presentation on butterflies at Toronto's High Park Nature Centre.

Box 14:
Knowledge Building Circle:
Caterpillars, Butterflies, and Chrysalises

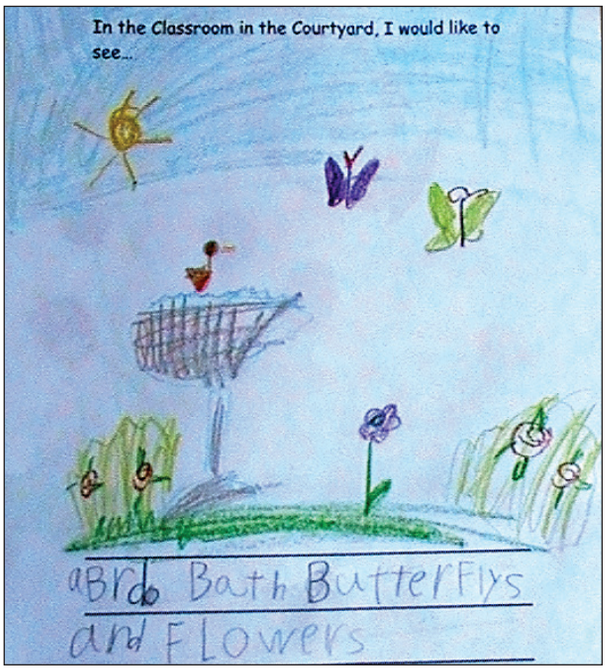
Amanda: I would like you to share what you wonder about caterpillars, butterflies and chrysalises. Close your eyes and think about that. The talking piece [rock] will come around. You may pass if you need more time to think. What do you remember about the way that we use the talking piece?
Student 1: Speak for yourself.
Student 2: Speak with respect.
Student 3: The person with the rock is the mouth and everyone else is the ears.
Student 4: How are the wings on the butterfly made?
Student 5: I'm wondering how caterpillars turn into butterflies in the cocoons?
Student 6: I was wondering how they turn from a caterpillar to a chrysalis to a cocoon to a butterfly?
Student 7: How did the first butterfly without another butterfly makes its eggs?
Student 8: How does a caterpillar know when to make a butterfly?
Student 9: I wonder what butterflies eat?
Student 10: I wonder how the butterflies fly with just their wings?
Student 11: I wonder how their wings get injured if nobody touches them.
Student 12: I wonder how the food is made for the caterpillars?
Student 13: How does the caterpillar peel off its skin?
Student 14: Why does the caterpillar eat its egg after it's born?
Student 15: I was wondering the same thing as [Student 14].
Student 16: I wonder how they eat their egg?

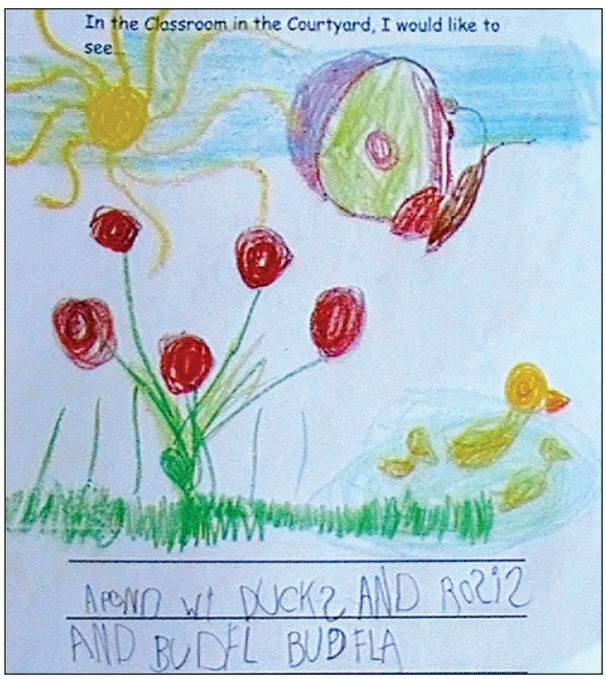
Stewardship

Releasing butterflies

The children had lovingly raised their caterpillars, observed their metamorphosis, and witnessed their spectacular emergence into Painted Lady butterflies. It was now time to release the butterflies outdoors. But where? The students chose a place that was both meaningful and accessible: the Classroom in the Courtyard.

They headed excitedly into the courtyard with their butterflies, only to discover that all the tall wild plants and grasses had been cut down. There was nothing in the courtyard for the butterflies to eat. Amanda learned later that an effort to control the spread of an invasive species was the reason for the pruning. But in the moment, the children were disappointed and saddened. The courtyard was special to them, affording a local sense of place and personal connection to nature, one that Sobel (2008) suggests is the foundation for developing a sense of stewardship.





Amanda wanted the students to think about their connection to the courtyard, rather than dwell on their disappointment. She asked them to describe, in pictures and in words, their ideal vision of what the courtyard could be, rather than what it had recently become. "What would you like to see in the Classroom in the Courtyard?" The students' drawings and words were revealing. They affirmed that the kindergartens cared deeply about the state of the courtyard. The disappearance of water under the bridge was both interesting and personal. It was their water that had disappeared. It was their bridge and their Classroom in the Courtyard. They knew about the courtyard's intimate details (disappearing water) and wanted to understand what was happening to it and why (evaporation).

It came as no surprise that the children's pictures conveyed a purely back-to-nature vision. There was no suggestion for a jungle gym or any other man-made product. Only ideas for greening, beautifying, and attracting butterflies and other wildlife. Amanda wondered about this. Perhaps this vision reflected the children's longing for the abundant garden they had known and loved, before it was reduced to stubble. Quite likely, it spoke of their sense of wonder about the natural world, of the joy and comfort they experienced when immersed in it.

Photo 78: A Back-to-Nature Vision

This connection may not have occurred had the children's initial learning about the environment focused on an ecological crisis.

The children's drawings and writing also served another function. In combination, these two modes of expression provided Amanda with a more complete picture of the children's thinking processes. In one drawing (See Photo 78) the child has simply written, "I want to see more nature." However, his drawing conveys exactly what he means by "nature" through his depiction of details such as grass, flowers, a butterfly, and the sun. This is precisely why it is so important to provide children with at least two modes of expression to convey their ideas.

Amanda's Final Word

"At the end of the year, I felt really refreshed and proud. I looked back at the entire process and adventure the students and I journeyed through, saw the amazing breadth and depth we engaged in, and I knew that this incredible amount of learning wouldn't have occurred had we just been covering month-by-month themes.

I also think it's a lot easier now to communicate with parents because they can really see that I care about what their children are involved in. I take a lot of photos of what the children are doing to help me explain things to the parents and they really appreciate that."

Key Concepts: Soils in the Environment, Factors Affecting Plant Growth, Water as a Necessity of Life

Subject & Skill Areas: Science (Earth and Space Systems), Language (Oral Language, Writing)

Focus of Inquiry: Differences in Soil Quality and Composition

The Grove Community School

Grades 2/3: Rhiannon's Story

Rhiannon has taught for three years, all in the Primary grades, at two different alternative schools in the Toronto District School Board. The Grove Community School was in its first year when she began there as a Grade 2/3 teacher, and all of her students had transferred from various other schools.

It was a unique situation: The school was working hard to establish its focus and its sense of "alternativeness". The class had a wide range of needs as well as expectations for its new school. And Rhiannon was introducing a new approach to teaching and learning!

Rhiannon was excited and hopeful, but also a little worried. How could she cover the Ministry's expectations for curriculum and planning and still use the Environmental Inquiry approach? "I came to realize that it is very possible to do both," she says. "I know I still have a lot to learn, but I am excited to continue on this journey."

Focus of Inquiry: Soil Quality and Composition

Starting the Environmental Inquiry Process

Photo 79: Exploring Different Soils

Rhiannon wanted to start off her inquiry into soils in the environment with a bang. She wanted her students to be curious, motivated, and in "science-thinking" mode. It seemed appropriate to invite real-life scientists from a non-profit education organization, Scientists in School, to conduct an introductory hands-on workshop on soils with her students. Scientists in School is a program comprised of more than 300 scientists who visit classrooms in over 150 communities across Ontario.

Several 'soil stations' were set up in the class, around which the students rotated. The Grade 2s and 3s dug their hands into different types of soils to explore variations in composition, texture, and water-carrying capacity. They built a soil profile and observed worms burrowing through soil. These introductory, hands-on experiences not only familiarized them with the topic, but also got them excited. Rhiannon was also excited because she knew that if the students were enthusiastic about what they were learning, they would want to take their learning further.

> *"They're all pretty excited about it, which I think is the key. If they're engaged and excited about what they're learning, they'll retain it; they'll want to explore it, and they'll stay on task, which is what I have found."*
> – Rhiannon Kenny, Grade 2/3 teacher

The next day, Rhiannon asked the students: "Think about your experience exploring soil yesterday. Did you learn something new that you didn't know before?" She then provided each student with two Post-it notes and gave two instructions to the whole class: The first was to write their new understandings on one of the Post-it notes. The second was as follows: "Think about something that you are still wondering about soil. Write a question about what you are wondering on your other Post-it."

The children's written responses helped Rhiannon understand how each child had benefitted from the workshop on soils, what had captured his or her interest, and if they had developed any misconceptions (See Table 20). Moreover, this opportunity for personal reflection was helpful to those children who preferred to think through an idea before sharing it with the group. And, as Rhiannon discovered, the Post-it notes would serve as presentation aids in Knowledge Building Circles. The children put them up on the board alongside those of other students, thereby making a tangible contribution to the knowledge of the class community (See Photo 80).

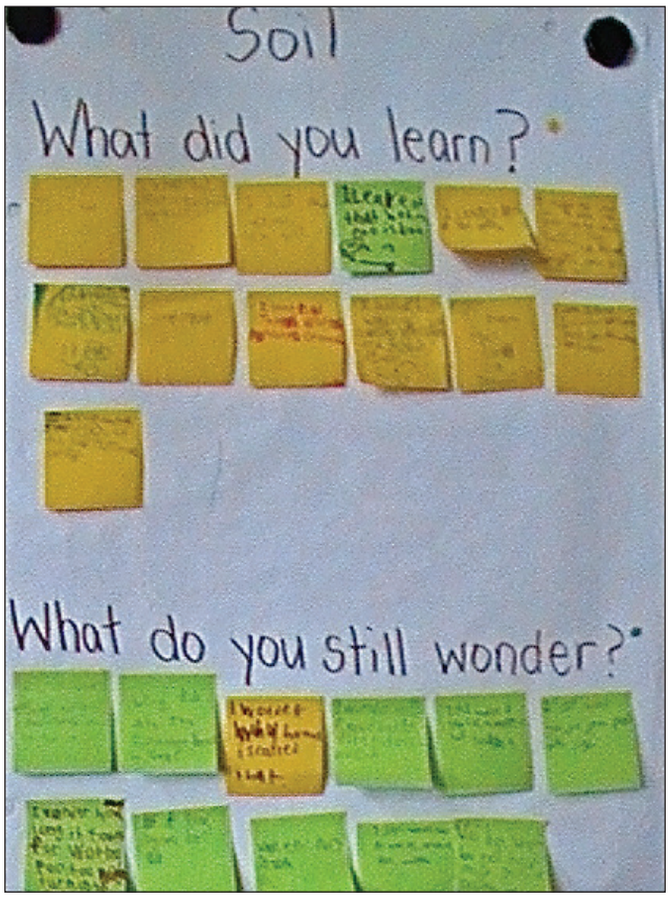


Photo 80: Using Post-it Notes to Share Thinking

Our new understandings of soil in the environment	What we still wonder about soil
"I learned that there are different layers of soil."	"What else lives in dirt?"
"I learned that worm poo is dirt."	"Can plants grow and survive in clay?"
"I learned that waves make the rocks rub together and that makes soil and it takes 1,000 years to make an inch of soil."	"Why do worms not have any eyes or noses?"
"I learned that roots can suck up soil."	"I wonder what it would be like if the whole world was soil."
"I learned that clay cannot hold that much water."	

Table 20: The Grade 2/3 Students Think About Soil

From the children's questions and ideas, Rhiannon recognized an opportunity to explore the relationship between plants and soil. She chose to focus the children's attention on a particular question: "Can plants grow and survive in clay?" Through this shift in focus, the children would build on their knowledge of soil, refine their questions, and investigate their theories through experiential explorations.

> *"I noticed that the students really love when their thinking is charted and put up on the wall. They love to see and hear back what they said before. When they are given that chance, they follow through on their thoughts and they're more engaged."*
> – Rhiannon Kenny, Grade 2/3 teacher

Rhiannon opened a Knowledge Building Circle with the question: "What do you think we can do to find out if plants can grow in clay?" One student's suggestion was "to plant a flower in clay and watch how well it grows". Another student disagreed: "The flower won't survive because clay does not hold water well and plants need water". Then another student chimed in: "Peat absorbs lots of water!" All at once, the students were imagining and predicting how a plant might fare in a variety of soil types compared to clay.

"Would you like to try that out? Grow a flower in different soils?" asked Rhiannon. The students were keen. Rhiannon was amazed. The Grade 2s and 3s had planned to explore one seemingly straightforward question, but now it was blossoming into an inquiry about the relative importance of different soil types on the healthy growth of plants.

Experiential Learning

Students design their own experiment

The class discussed which type of soil, in addition to clay, to use in their experiment. Drawing upon their workshop experience with the Scientists in School, they agreed that sand should also be included as one of the "experimental conditions". They also agreed on peat moss, at the suggestion of a student whose family used it in their garden, and on left-over potting soil from the classroom vegetables they had planted the previous week.

Rhiannon asked some carefully crafted questions in order to scaffold her students' thinking about their experimental design. Some of her questions included:

- "What can we do to be sure that the soil we use in each pot will be the only thing that affects the changes we may see to our plants?"
- "Should we choose different plants for each of the soil types? Why or why not?"
- "How much water should give to each plant? Why or why not?"
- "Where should we put each plant? Why?"

In response to this skilful questioning, the Grade 2s and 3s agreed to the following experimental controls:

- The same type of flower (petunia) should be planted in each flowerpot.
- The four flowerpots should be exposed to the same amount of sunlight.
- The four flowerpots should receive the same amount of water.

Peat Moss

Sand

Clay

Potting Soil

Making predictions

Students' predictions are valuable sources of information in that they provide teachers with a view into students' expressive language skills, as well as their thinking and reasoning skills. By simply deconstructing a student's prediction, a teacher is able to gain insight into a number of important questions:

- *"Does this student communicate his or her idea clearly and effectively?"*
- *"Do I and others understand what he or she is trying to say?"*
- *"Is this student applying and building onto previously learned concepts?"*
- *"Does this student offer information to support his or her theory?"*
- *"Does this theory reveal a misconception?"*
- *"What is the source of this information?"*
- *"Does this student draw upon multiple sources to support his or her theory?"*

As the predictions shown in Photo 81 illustrate, the students drew upon different experiences and sources of knowledge to construct their theories. Some students provided a scientific explanation, applying the vocabulary they had acquired from the Scientists in School workshop on soil. Two students based their theories on an immediate observation, while another student based her theory on personal experience (her family's use of peat moss).

Despite these advances, an earlier misconception resurfaced: the children were still convinced that clay was a healthy environment for plants because of its water absorption capacity. Still, students benefited from hearing a diversity of ideas that they may not have considered otherwise, such as those presented in workshops and KB Discourse.

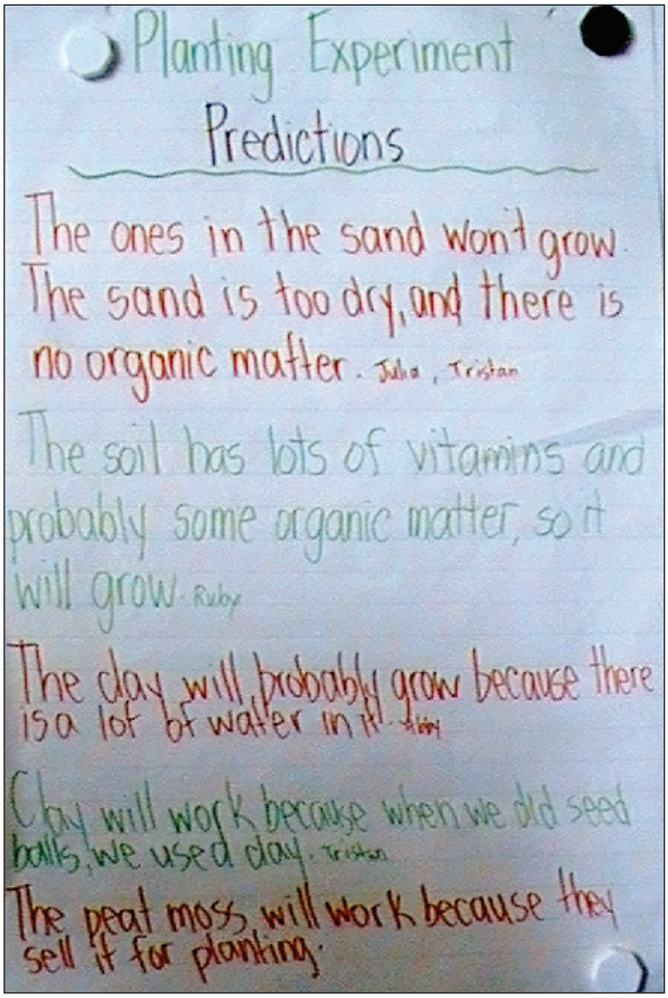


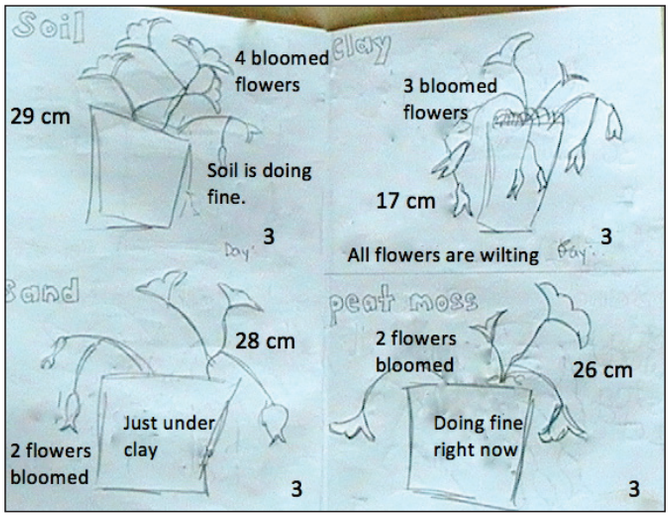
Photo 81: Students' Predictions

> *"I never really realized what I could do with what was said in class discussions, how it could guide teaching, or how students can learn from each other. We had conversations in the past, of course, but knowing what to do with what they say in Knowledge Building Discourse, that's new. I've learned a lot about going back and looking at what the kids say and writing things down and using that to guide my teaching, which I hadn't thought about before. It was conversation for the sake of conversation. It was sharing ideas but without thinking that they could possibly lead to a whole unit."*
> – Rhiannon Kenny, Grade 2/3 teacher

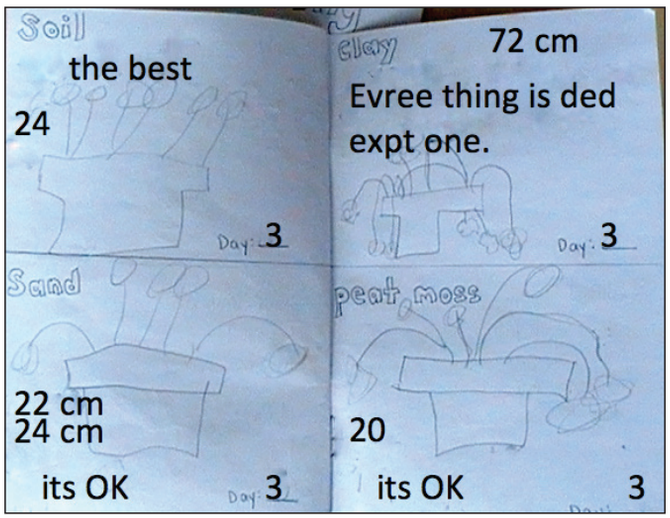
Close observation of natural processes

The children monitored each of the four experimental conditions, regularly recording their observations in their Planting Experiment Books. While many students used a variety of forms to communicate their findings, all the students made detailed illustrations of the physical differences among the four plants (e.g., the number of blossoms and the flower's structural stability). The students complemented their drawings with written descriptions. A number of children measured the height of the plant, and even that of each stem.

The Grade 2s and 3s observed the intense manner in which clay absorbs water and the resultant effect on plants. They came to realize that clay's absorbent nature is not beneficial to the growth of plants, that clay absorbs too much water, leaving none for plant roots. They also noted the difference in growth between plants in organic versus inorganic matter. They were surprised that the petunia in sand was faring better than the petunia in clay because it was receiving at least some water.



* Text enhanced to ensure legibility. Original grammar has been maintained.



* Text enhanced to ensure legibility. Original grammar has been maintained.

Just as the children predicted, the petunia planted in potting soil thrived the best of all. (Potting soil contains both organic and inorganic matter and allows for water drainage.) This experiment enabled the children to make an important collective knowledge advance based on their initial question: "Can plants grow in clay?" They now understood that different soils affect the capacity of plants to take in water, and that to thrive, a plant needs to be in soil with the right balance of ingredients.

Rhiannon's Final Word

"I was very excited as we progressed through a unit to see the students' own questions being explored in meaningful ways that fully engaged them. And I was also excited to see the expectations in my long-range plans being covered.

By the end of this professional journey, I came to realize that you can cover the Ministry's expectations for curriculum and planning and still use Environmental Inquiry!"

Key Concepts: Characteristics and Needs of Living Things, Growth and Change of Plants and Animals

Subject & Skill Areas: Science (Life Systems), Language (Oral Language, Reading, Writing)

Focus of Inquiry: What is a living thing?

Rose Avenue Public School

About Rose Avenue Public School: An inner-city Toronto school with a diverse student population drawn from the 22 apartment towers which surround the school, in one of the most densely populated neighbourhoods in Canada. More than 74% of the students have English as their second language (representing about 50 language groups) and half of the families of this school are recent immigrants to Canada.

Grades 1/2: Susanna's Story

Before joining the pilot program, Susanna Chwang had been teaching for nine years at the elementary level. She taught Grades 1 to 4, spent two years as a Methods and Resource Teacher (MART) and worked with Grades 5 and 6 students in special education classes and extracurricular activities.

As a long-time proponent of Environmental Education and Experiential Learning, Susanna was excited about following her students' interests and embracing a "student-centred" teaching approach, even though she had "an extremely challenging class" with no previous experience with Inquiry.

"It was a lot of trial and error," says Susanna. "There were huge missteps on my part and a lot of confusion. This was a new kind of learning experience for my students. They were not accustomed to sharing their own questions and theories with one another. I discovered a need to explicitly scaffold the process of asking, responding, and engaging in Knowledge Building Discourse. Soon enough, however, Environmental Inquiry became a fascinating journey! The students and I learned a lot about how to ask and answer questions, how to listen, and what it means to share and utilize each other's knowledge and ideas. I knew that this was an important step, that this was not an 'all or nothing' process, and that I was helping my students build essential learning skills."

Focus of Inquiry: What is a Living Thing?

Starting the Environmental Inquiry Process

Susanna realized that it would make sense to combine two strands within the Grades 1 and 2 Science curricula (Growth and Change of Animals, and Needs and Characteristics of Living Things respectively) into a single inquiry: "What is a living thing?" After all, Susanna reasoned, growth and

change are characteristics of living things, and living things have biological needs that enable them to grow and change.

Film, interactive read-alouds, hands-on experiences, and opportunities to engage in dialogue about the topic were the ways in which Susanna explored this Environmental Inquiry with her students. She started off by showing the film adaptation of Margery William's *The Velveteen Rabbit*, a children's novel about a stuffed rabbit's quest to become a real live rabbit.

> *"We all have our biases – I have my own bias of what I think the children should learn. Unless I give them a chance to share what they want to talk about, I will simply continue to teach according to my own assumptions. They may feel as though their culture or some important aspect about them is not important."*
> – Susanna Chwang, Grade 1/2 teacher

Identifying misconceptions: Opportunities for idea improvement

After the film, the students gathered in a Knowledge Building Circle to discuss the difference between the stuffed Velveteen Rabbit and the real live rabbits in the movie. This discussion revealed the children's initial understandings about what it means to be "living," "real" or "imaginary". The children seemed to equate the word "real" with "living". They considered cartoon programs to be "not real," whereas fictional television characters portrayed by real people were considered "reality".

Photo 82: Grade 1/2s in a KB Circle

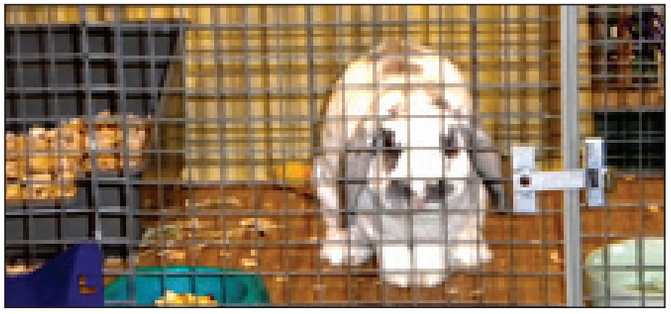
Addressing the needs of all learners

Before directly addressing this misconception, Susanna wanted to ensure that she presented this domain in an accessible manner to all of the learners in her class. "One of the most critical factors in the academic success of English language learners is the acquisition of academic vocabulary" (Ontario Ministry of Education, 2005a, p. 27). Thus, in order to scaffold her students' thinking with the kind of vocabulary that would enable them to participate in future discourse about living things, Susanna read aloud the picture book, *Near One Cattail*, a story about a young girl who ventured into nature and noticed the myriad of living things around her. As exemplified by the story's protagonist, Susanna emphasized the importance of "really noticing" all the living things in the story, a skill that they would later put to use on their Community Walk. The children identified many creatures in the book including those that swim, fly, and crawl, and were exposed to a rich bank of descriptive vocabulary accompanied by vivid illustrations.

Primed by this interactive read-aloud, the class went on a Community Walk. They worked in pairs to list all of the things that inhabited the vicinity of their school community. This experience also served to engage the students who thrive in more hands-on learning contexts.

Positing Theories

After these lead-in experiences, Susanna felt that her students were ready to revisit their earlier misconceptions about the characteristics of living things. To provide her students with a concrete foundation for comparing the characteristics of living and non-living things, as well as lead them to consider the needs of animals as they grow and change, Susanna brought two guests into the classroom: her live rabbit, Alex, and a stuffed toy rabbit.



The students considered what characteristics made one rabbit "alive" and the other not. To obtain a sense of each individual student's emerging understanding, Susanna gave each student two sheets of paper divided into quadrants. On the first sheet, she asked the children to draw and label four pictures of living things, one picture for each quadrant. On the second sheet, each child followed the same instruction, only using non-living things as the subject of their drawings. These drawings represented their theories and, for Susanna, provided an assessment of their emerging understandings about the characteristics of living things (See Photos 83 and 84).

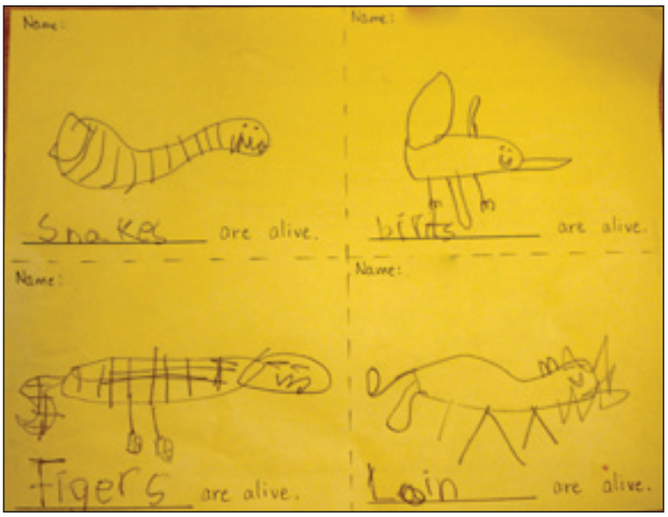


Photo 83: What is Living?

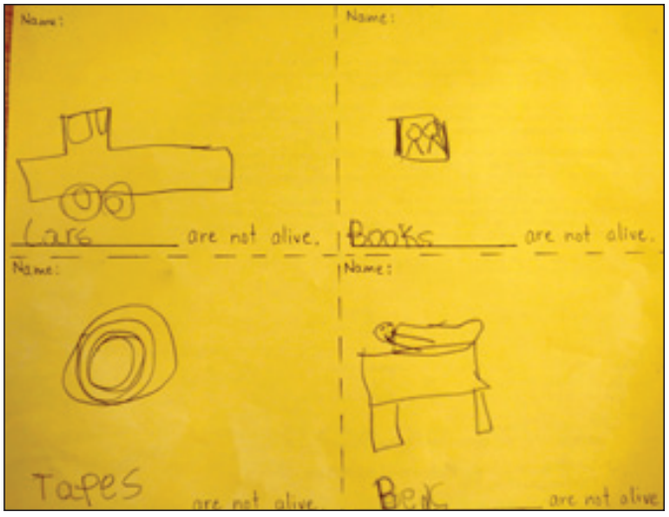


Photo 84: What is Not Living?

Although semantic issues may have contributed to the children's confusion over dichotomies such as alive/not alive and real/imaginary, the children generally agreed that animals, including the new classroom rabbit, Alex, are living things. Susanna used this point of consensus to inform how she would move forward.

Bringing theories together: Collective Knowledge Building

Susanna gathered the Grade 1s and 2s together in a Knowledge Building Circle to create a consolidated list of characteristics of living and non-living things. To determine which items from their drawings were, in fact, 'living' and which were not, the students needed to agree on a set of characteristics upon which to distinguish these two categories. This would involve contributing and negotiating their ideas to form a collective theory for the question, *"What is a living thing?"*

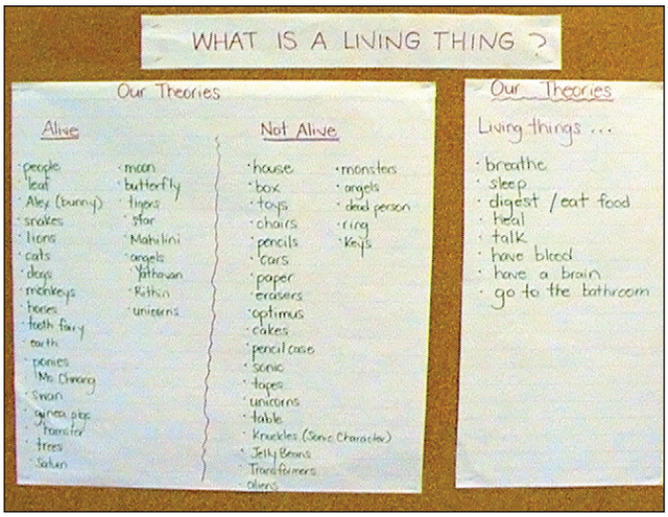


Photo 85: Bringing Individual Knowledge to the Whole Group

> *"In a diverse community especially, I think it's critical for students to ask questions; if you don't allow students to share their thoughts, you will never get to the things that they know, don't know, and want to know."*
> – Susanna Chwang, Grade 1/2 teacher

Susanna initiated this discussion by selecting an image from the children's set of drawings that they all agreed represented a living thing: Alex, the classroom rabbit. Susanna then asked the students, "Is Alex a living thing? What is it about Alex that helps us know he is living?" As the children shared their ideas, Susanna documented the their responses (e.g., "he breathes," "he sleeps," "he eats").

Susanna chose another widely agreed upon example of a living thing: one of the students in the class. She asked the class: "Is Mahalini a living thing? Does she have any of the characteristics that you mentioned Alex the rabbit has?" The children agreed that Mahalini was a living thing. They were able to contribute even more common characteristics of living things than previously (which Susanna documented). Susanna displayed the class' new theory next to their initial list of living and non-living things, providing an ongoing reference of the children's collective idea improvement.

Only after the children had an express opportunity to state their own ideas about the question: "What is a living thing?" did Susanna proceed to move the Environmental Inquiry further by suggesting: "Now that we have talked about what we think makes something living, maybe it's time for us to look at some books in order to find out what other people think". She introduced the children to the excellent selection of resource books by Bobbie Kalman about living things, providing periods for individual reading/looking at books, interspersed with guided, interactive read-alouds (details on page 158 in References).

Revisiting and negotiating ideas

After the students consulted this variety of authoritative sources, Susanna wanted to assess whether the students' theories about living and non-living things had changed in any way. To do this in a collaborative way, the class revisited the same set of drawings that they made earlier (See Photos 83 and 84). They separated their quadrants cutting their sheets into four. The group consolidated all of their quadrants, sorted them into categories and negotiated what they thought were the similarities between animals and other living things.

As the children gained more information about living things," Susanna facilitated Knowledge Building Discourse to support their collective understanding. For instance, she encouraged them to compare their initial theories (posted on the display board) with their current understandings, asking:

- "Does what you learned today change your theory about what makes something living?"
- "Do you have anything else to add to your list of living things?"
- "Are there any characteristics that you would change or remove from your list?"
- "Is there anything new that you would add to your theory?"

Building ongoing curiosity

Each new learning discovery served to fuel the children's curiosity and sense of wonder. To encourage new questions, Susanna asked the students to share what they knew so far about animals and other living things, and then share new questions. From a list of approximately 20

questions, Susanna selected five that she thought would lead to a deeper investigation and to the learning goals she had set for the class.

Five Student Questions About Living Things

1. Do all living things need food and water?
2. Are plants alive?
3. Why do plants need soil and worms?
4. Do plants need food?
5. How do animals grow?

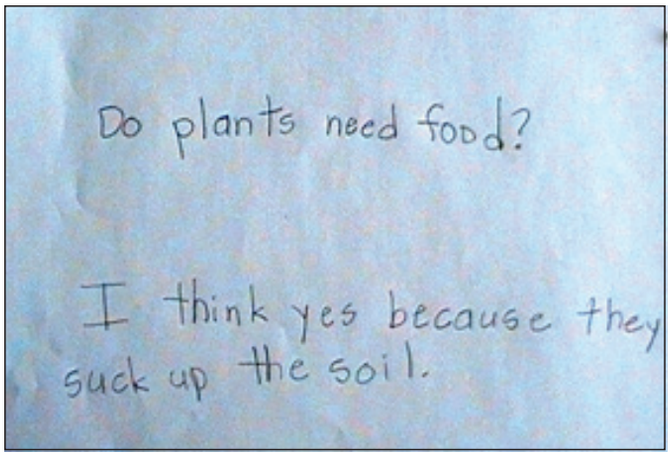
Each child selected a question from the list of five and worked with three or four other students to investigate this question fully. They reflected, discussed, and wrote responses that represented their current theories about this question.

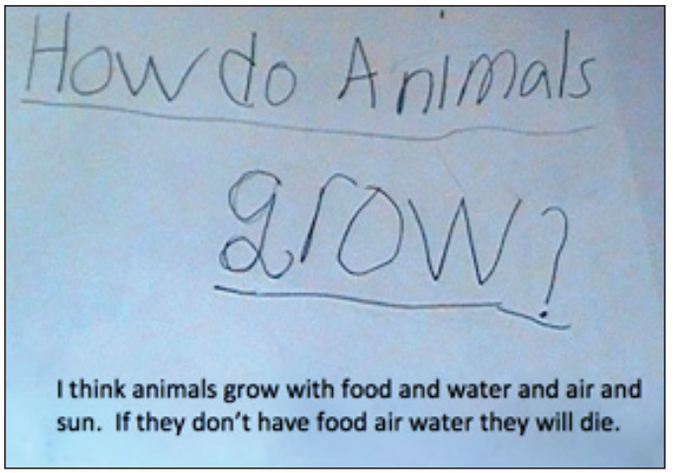
"Oral language skills are a critical component of literacy in any language. When you give students frequent opportunities to converse in English, you stimulate the development of listening and speaking skills, give students a broad sense of the English language and it's construction, and help English language learners connect with their peers and develop self-confidence."
– Ontario Ministry of Education, *Many Roots, Many Voices* (2005a).

The children shared their theories in a Knowledge Building Circle (See Photos 86 and 87). Susanna used this occasion to foster the children's sense of agency over their own learning, asking: "How do you know if your theories are correct? What can you do to find out?" Instead of telling them how to resolve these issues, she got them thinking about the solutions for themselves. The children shared many ideas and solutions including: experimentation, researching books and the Internet, and consulting expert sources (See Box 15). Susanna displayed the children's questions on the board and surrounded them with students' growing ideas that emerged with each Knowledge Building Circle.

Box 15:
Knowledge Building Circle:
Planning the Investigation

Student 1: My question is, "Why do plants need soil and worms?" I will test it out my theory. I could plant a plant in soil with worms and watch it grow.
Student 2: My question is, "Do plants need food?" My theory is that plants do need food because they suck up the soil. They eat the soil. I will test it out outdoors.
Susanna: What would your test be?
Student 2: I would take a plant and see if it sucks up the soil. Then I will put water in it.
Student 3: Why do all living things need food and water? My theory is that living things need food and water or they will die.
Student 4: How do animals grow? Animals need water, and I think sun makes animals grow.
Susanna: How will you find out?
Student 4: I don't know.
Student 3: We can look on the internet or in a book?
Susanna: How do you know if the people on the internet or the book are right or wrong?
Student 5: Maybe you need to ask a scientist the question, "How do animals grow?" and maybe he can help.
Susanna: Where are you going to find a scientist?
Student 5: On the Internet.
Susanna: Does anyone know an expert that could help to answer your question?
Student 3: On TVO kids.com you can ask a question on a show called "Ask Sarah".
Student 6: There is a show called TQ and I know the website for it. It is *crossroads.ca/tq*. There is an animal scientist on the show who is an expert. I think the scientist will be able to help us with the question, "How do animals grow?" and "Do plants need food?"
Susanna: Who do we know that are experts about soil and worms?
Student 1: Green Thumbs Growing Kids!
Susanna: Who would be an expert on the question, "How do animals grow?"
Student 5: My auntie is a scientist for real. I could email my auntie with a question.
Student 6: I learned from TQ that iguanas can grow about 20 feet big. I also learned from the plant expert not to put your plants in too much sun. It could get too hot and make the flowers droopy.
Student 7: How do animals grow? Animals grow by eating food. If animals don't eat food they will not grow and they will die.
Susanna: Why don't we write a letter to some of the experts that you have suggested?





Photos 86 and 87: Students' Questions and Initial Ideas*
* Text enhanced to ensure legibility. Original grammar has been maintained.

Susanna's Final Word

"I hope teachers reading this resource realize that they can take this system and make it their own. Even if you're only able to take just the first few steps, getting students to make decisions about their own learning is of great importance. If they can do that, it will get them ready for the next step when it appears. After all, what is more interesting and important than to be able to delve into the inner workings of our students' minds?"

Key Concepts: Origin of Food, Energy Conservation

Subject & Skill Areas: Language (Oral Language, Writing), Mathematics (Measurement)

Focus of Inquiry: Local Gardening

Rose Avenue Public School

Grades 4/5: Kathleen's Story

Over the past decade, Kathleen Quan has taught Grades 3 to 8 at different schools in downtown Toronto. She was drawn to the pilot project because she was "concerned about the environment," and knew that her Grade 4/5 class "would benefit from the experiential learning".

Although Kathleen felt confident at the beginning of the project, she soon came to realize that not only were the students "undergoing a shift" in the way they were learning, but she "was also changing". Initially, she worried whether the children were "learning everything they needed according to the curriculum" and wondered about her own responsiveness to the direction the children's inquiries would take. Kathleen's fears, while natural, inevitably fell by the wayside.

"As we got going, the class was so engaged, enthusiastic, and productive that I was able to relax and keep the big picture in mind," recalls Kathleen. "By the end of our year of Inquiry, the class was so adept at making connections, comparing, asking questions, and considering ways that questions could be researched and addressed, that it was clear they had learned a lot and had better skills and knowledge."

Focus of Inquiry: Local Gardening

Starting the Environmental Inquiry Process

Building a school garden of edible plants is a sure-fire way to create learning experiences that dovetail all four goals of Environment Inquiry: Inquiry-based Learning, Experiential Learning, Integrated Learning, and Stewardship. This is precisely what Kathleen had in mind when she collaborated with Green Thumbs Growing Kids, an organization that works with urban children, youth, and their families to learn about, grow, and prepare fresh foods. The Grade 4/5 project would serve as a practical application and an extension of the students' previous inquiries into both human health and the conservation of energy. Moreover, spring was approaching and the prospect of warmer days meant that the students could spend more time outdoors!

"When I think of the things that actually shaped me as a student, it was never any of those tests or those kinds of experiences in school. They might have been important at the time, but they sure were not memorable. I suppose I'd rather have my own students do things that are more likely to be memorable."
– Kathleen Quan, Grade 5/6 teacher

Planning and preparation: Location, location, location

With the goals of student-centred, inquiry-based learning in mind, Kathleen ensured that her students took the lead in designing and building a school garden that the entire school community would enjoy. The children were engaged in every aspect of the project, from selecting the best location to deciding what to grow in the garden.

The students began their planning process by looking at maps of the school grounds to gain a sense of the available space. Kathleen then brought the whole class outside, maps in hand, to scrutinize the site options proposed by different students. It was not until they had spent time outdoors that the students truly came to appreciate the importance of other factors (in addition to space) in creating the ideal place for a garden. When the class gathered in a Knowledge Building Circle designed to reach a final consensus, they considered and negotiated a number of pertinent issues, such as pedestrian traffic, access to water, and exposure to the right amount of sunlight, before making a final decision.

Framing the space

While it was already determined that the garden would be a raised bed enclosed by brick, Kathleen wanted the students to learn, firsthand, how the bricks were made as this was an integral part of bringing the garden to fruition. To do this, she brought her class directly to the source – The Fifth Wind Farm, in Coburg, Ontario.

The students would not be framing their garden with just any ordinary bricks. Rather, they were going to use Earth Blocks, a special "air dried" type of block comprised of only 10% cement, that requires much less energy to produce compared to regular bricks. The students witnessed Earth Block machines at work, how their various pulleys and gears moved the production process along, and they lifted the bricks themselves, surprised to discover how heavy they were. The children were very excited but would have to wait several weeks for the Earth Blocks to be delivered to their school.

What's the point?

The extent to which her students perceived the larger purpose, or 'big idea,' behind the garden project was, in Kathleen's estimation, enormously important. Often, when classes engage in extensive collaborative projects such as this one, they risk simply "going through the motions" of putting a garden together and easily lose sight of the larger meaning or purpose. Kathleen wanted to ensure that this would not happen. Thus, she set out to understand what her students were thinking about with regard to this project. This would help her to facilitate their ongoing idea improvement.

The Grade 4/5 Students Discuss…

"Why even have a garden in the middle of the city?"
"We can grow our own food."
"The plants look pretty."
"It makes us care about our neighbourhood."
"It makes me feel happy."
"It makes more green in the neighbourhood so there is more oxygen."

"I must say the circle configuration of our Knowledge Building talks is powerful. Kids contribute more, and it eliminates cliques and the need to shift kids. They listen to each other better and shy people seem emboldened. It is generally more purposeful and creates a more dynamic and multi-directional social network."
– Kathleen Quan, Grade 4/5 teacher

Kathleen and the students came together in a Knowledge Building Circle, where they discussed fundamental concerns such as: "What is the point of all of this? Why even have a garden in the city?" Kathleen scribed each student's theory on chart paper, and the entire list of theories was displayed on the wall. Kathleen would often return to this list as she thought about next steps in her planning.

The students' responses were quite insightful, touching upon a number of big ideas related to:

- empowerment ("We can grow our own food.")
- aesthetics ("The plants look pretty.")
- social responsibility ("It makes us care about our neighbourhood.")
- emotional affect ("It makes me feel happy.")
- environmental stewardship ("It makes more green in the neighbourhood, so there is more oxygen.")

Linking students' ideas to key concepts

Kathleen also recognized the opportunity to build onto the students' ideas, to move from a basic understanding of the benefits of locally-grown food to an appreciation of more connections, such as the relationship between locally-grown food and reduced energy consumption. Using the idea of locally grown food as the pathway for idea improvement, Kathleen purchased various items at a local grocery store, all of them imported: apples from Chile, herbs (mint, basil, oregano) from the Dominican Republic, a potato from the United States, an onion from Mexico, and a tomato from northern Ontario. These were the same items that the children had grown (or could conceivably grow) in their school garden. However, as the children would come to understand, the ecological footprint of imported food was significant, although not obviously apparent until they looked at other issues such as transport.

To help the children make these important connections, Kathleen held the Chilean apple high up for the children to see. This simple act served to reconnect the children personally to an earlier experience: the school-wide "Big Crunch," where the entire school population stood outside and simultaneously crunched into an Ontario apple. Kathleen asked: "Before this apple was here, do you know were it might have come from?"

Kathleen gave the children a moment to share their ideas. Most students assumed that the apple came from either an Ontario farm or supermarket. Kathleen showed them the label on the apple: "Product of Chile". The children were surprised on two accounts: first, they hadn't realized that fresh food bore labels indicating where they came from; and second, that an apple in their Toronto classroom had come all the way from Chile.

The Chilean apple had come a very long way, Kathleen explained, and had probably passed through many hands before arriving at the Toronto grocery store. She drew a horizontal line across the width of a sheet of chart paper and marked "apples" three-quarters of the way along the line. The class helped to create a timeline of all the steps involved in getting the Chilean apple to their classroom. Kathleen helped the students organize their thinking by modelling how to work backwards along the supply chain. "Where was it right before it was in our classroom? Where was it right before that?"

The children worked backwards until they arrived at the beginning of the timeline: an apple orchard at a Chilean farm. Their timeline showed the different steps of production and transportation involved in bringing the Chilean apple to their classroom. Before asking the children to break out into groups, Kathleen prompted them to think about other details in the supply process: "What does the truck need in order to transport the apple? How far did the truck, ship, or plane have to go? How can we find out?"

The Grade 4s and 5s broke out into groups of approximately three or four students to create timelines for the other vegetables and herbs that Kathleen had purchased from the supermarket. Each group focused on a different vegetable or herb so that they would each have something different to contribute to the whole group at the end of their collaborative work.

Determining the origin of some produce items was not always straightforward. As one group discovered, the label on their item identified the farm, but provided no details about its location.

> *"The students have a good idea about the conservation of energy now. I feel they have become confident thinkers and collaborators and that this is largely a result of the thinking work they have done this year. The class has really benefitted from it."*
> – Kathleen Quan, Grade 4/5 teacher

The groups used Google Maps to locate where their produce had been grown. Most of the groups tried to calculate how far the food had travelled, but some had no understanding about how food travelled. Kathleen explained that food is often transported by truck, which enabled the students to move beyond their initial confusion and to consider the implications of that mode of transport.

The whole group reconvened to discuss and compare their findings. When Kathleen prompted the students with the question, "What does a truck, plane, or ship need in order to move?" many student responses revealed an understanding that the transport of food involves the use of fossil fuels.

Kathleen then asked the students to engage in a variation of the same exercise: to consider the steps involved in bringing a vegetable or herb from the school garden to their tables. The students clearly understood that the ecological footprint of imported food is much greater than that of locally-grown food, and that the transport of imported food entails the consumption of fossil fuels. These connections had not previously occurred to them. A simple inquiry into the travels of a Chilean apple had advanced the knowledge of the community.

As a result of this experience, the students refined their initial question ("What is the point of creating a garden in the city?") to a statement that demonstrated a higher level of understanding: "We can grow our own food…and conserve energy by not depending on too many fossil fuels to get our food to us."

Integrated Learning

Procedural writing

The students thoroughly enjoyed their visit to the Fifth Wind Farm in Coburg, Ontario, where they observed the production of the Earth Blocks they would use to frame their school garden. Kathleen decided to capitalize on this meaningful experience by asking the children to apply their skills in procedural writing.

The pre-writing phase began with a class discussion, enabling the students to discuss their memories of the Earth Block-making process. Kathleen showed the students the photographs she had taken of their visit to Fifth Wind Farm. This served to trigger the students' memories, enabling them to vividly recall the experience. This was important for those children who needed a prompt of some kind to help them recall specific details.

"I pay a lot more attention now. I have just noticed this about myself. I pay attention to everything: to the notes that they make to things that they ask me. I'm just more aware of the process. But I think you have to do it very consciously."
– Kathleen Quan, Grade 4/5 teacher

The children returned to their tables and Kathleen distributed the photographs among them. Using a sheet of paper divided into six equal parts, the children took notes about each step of the brick-making process, referring to the photographs as needed (See Photo 88). Next, they consolidated their notes into a polished set of procedures about brick making. Kathleen was delighted to see that the children had recalled the wide range of brick-making vocabulary (e.g., compression, pulleys, gears). It was clear to her that by witnessing the process and revisiting it together as a group through discussion and visual cues, the students were able to bring extraordinary detail to their writing. The writing exercise not only gave Kathleen insight into her students' written expression, but also confirmed the students' high level of engagement with the excursion experience.

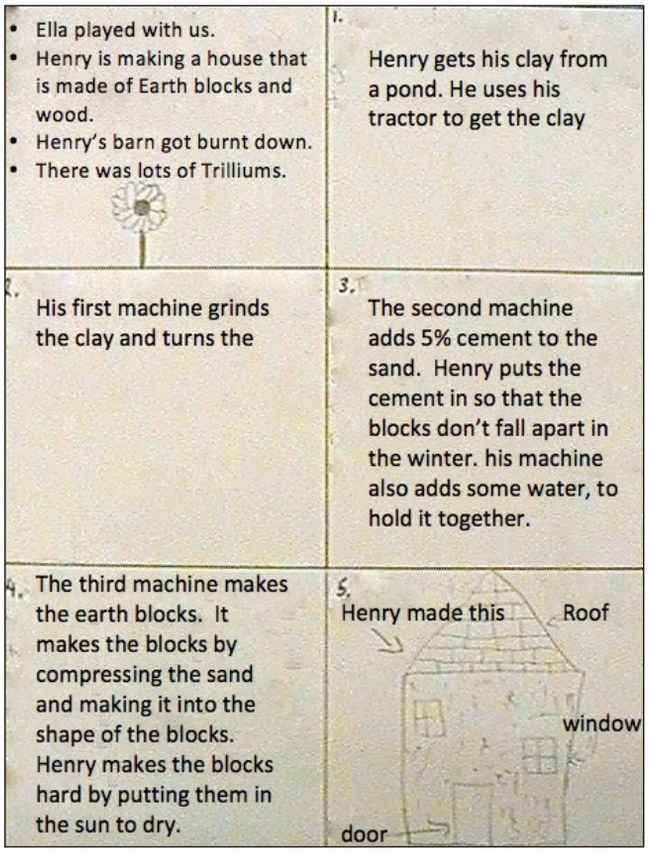


Photo 88: Notes of the Brick Making Process*
* Text enhanced to ensure legibility. Original grammar has been maintained.

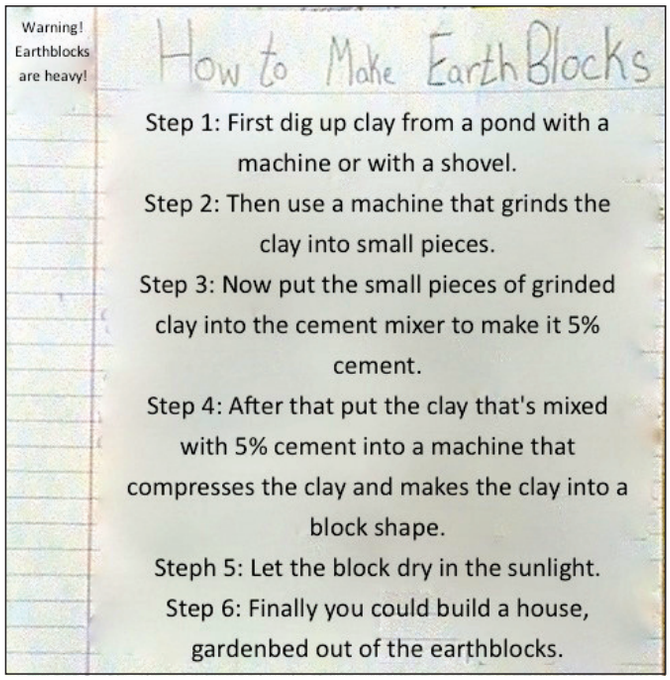


Photo 89: A Procedural Writing Sample*
* Text enhanced to ensure legibility. Original grammar has been maintained.

Math: Area, perimeter, and volume

Kathleen recognized that her children had an opportunity with the school garden project, to exercise their own leadership and decision-making. Numerous decisions needed to be made before the soil could be turned, such as determining its shape and dimensions. The school garden provided numerous opportunities to apply mathematical concepts related to measurement and geometry. Kathleen asked the children to design their ideal garden, considering its perimeter and area specifically, as well as the following parameters:

- The shape of the garden could only have 90 degree angles.
- Maximum number of bricks used: 120.
- Maximum area: it could not be larger than the reach of a kindergarten child.

Although Kathleen provided these parameters, she was mindful of the larger purpose behind this exercise: to get students thinking deeply about what they were about to do and why, rather than simply wait for her to tell them what to do. Therefore, Kathleen crafted directions to elicit their critical thinking, to encourage them to consider particular problems analytically, before 'heading out the gate'. This approach differs fundamentally from more traditional strategies (See Table 21).

The students used Lego building blocks to help them plan out their design in a concrete, visual way, keeping in mind the agreed-upon parameters. They spent a whole period experimenting with different shapes and designs until they were satisfied with their models. Kathleen then provided each student with a sheet of grid paper on which to sketch a blueprint-like design of his or her model. The class discussed the purpose of using this grid paper: It would be a tool for making precise mathematical calculations such as measuring the garden's perimeter, calculating the volume of soil required, and choosing an appropriate scale (i.e., of each square on the grid). They drew their plans on the grid paper and accompanied their design drawings with explanatory text.

Table 21: Designing the Class Garden: Traditional and Inquiry-based Approaches

Traditional Instruction	Inquiry-driven Questioning
"You will need to measure the reach of every child in JK with a measuring tape and calculate the average reach of all of the children."	"If we know that our garden can't be wider than the reach of a JK student, what do we need to do in order to make sure that we do that? How can we find out?"
"What you will have to do now is find out how much soil we need for the garden by using the formula for volume that you have been learning about."	"How can we find out how much soil we need to fill our garden? What do we need to know?" "If we were teaching children at another school how to build a garden exactly like this one, how could we find out the volume of soil that is needed?"

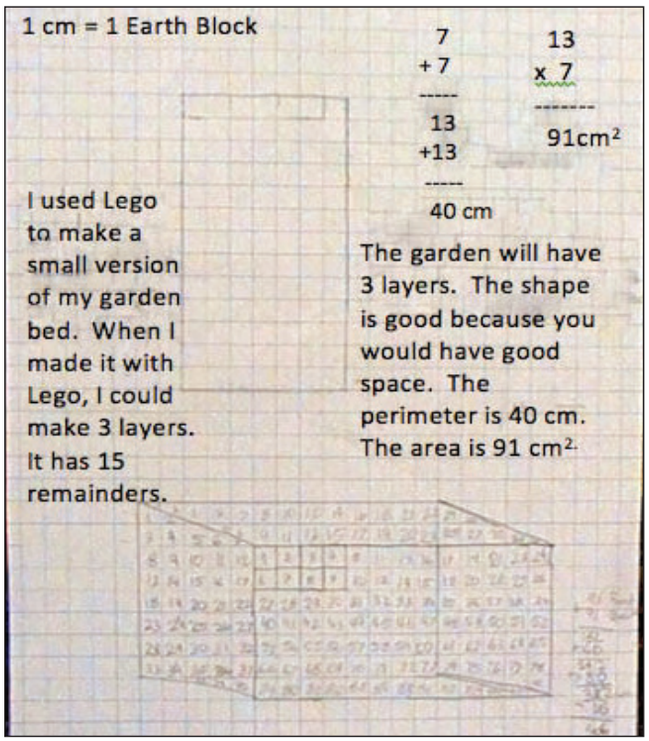


Photo 90: Student-designed Garden Blueprint 1*

* Text enhanced to ensure legibility. Original grammar has been maintained.

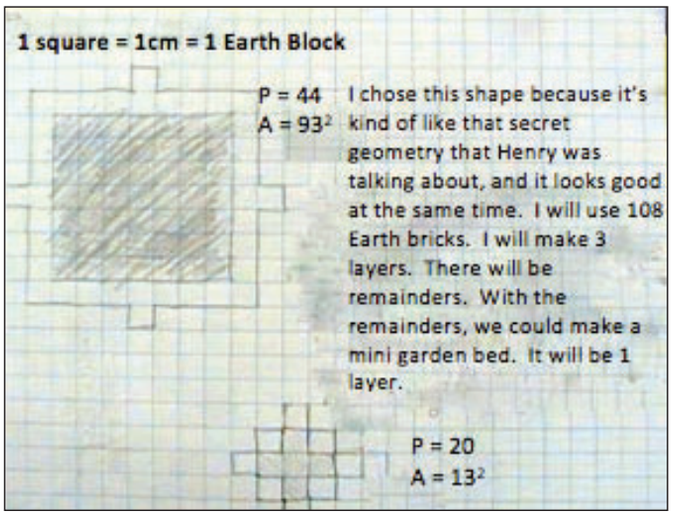


Photo 91: Student-designed Garden Blueprint 2*

* Text enhanced to ensure legibility. Original grammar has been maintained.

These rich artefacts provided Kathleen with valuable information about her students' mathematical understanding both in a discrete way and in an applied design context. Kathleen provided qualitative assessment feedback to her students directly on each of their blueprints. If, Kathleen were looking for a more standard assessment tool, she may have opted to create a task specific ICE Rubric with her students, as illustrated in Table 22.

Table 22: Example of task specific ICE Rubric for Grade 4 / 5 garden blueprints

ELEMENTS / CATEGORIES	IDEAS	CONNECTIONS	EXTENSIONS	
	Level 1	Level 2	Level 3	Level 4
Mathematical Knowledge and Understanding (e.g., perimeter, area, and volume)	I can calculate one or more of the following measurements: area, perimeter, and/or volume.	I can calculate the area, perimeter, and/or volume and show my thinking in numbers, pictures, and/or words.	I can create a scale for my sketch (e.g., 1 cm = 1 Earth Block).	I can use my knowledge of area, perimeter, volume, and the needs of plants to make the best use of space for the garden.
Design of garden (e.g. clarity and utility of sketch)	I can do a basic sketch of the garden using gridlines.	I can make a sketch that meets the design requirements (i.e., 90 degree angles; no more than 120 bricks; no wider than a kindergarten child's reach.	I can provide a rationale for my design (i.e., connecting to my previous Lego model, or personal experience). I can make sure my sketch is 'to scale'.	I think my sketch is clear and complete enough to be used as a blueprint for building the garden.

Kathleen's Final Word

"I think it's really worthwhile having children engage in experiences in which they learn how to question things in and of themselves, especially in a school like this, where kids are from a lower socioeconomic background, and most of them do not have English as their first language. They need to learn this way because they need to be empowered to ask questions and be critical of what's going on around them. I think that's really important.

There's a much higher level of student engagement and it's more interesting to me and more fun. Also, it's a little bit more relaxing to know that kids are interested in what they're doing. It's just a nice feeling for a teacher."

Key Concepts: Conservation of Energy and Resources

Subject & Skill Areas: Science (Earth and Space Systems), Language (Oral Language, Reading, Writing), Research Skills

Focus of Inquiry: Alternative Energy Sources

Our Lady of Fatima Catholic School

About Our Lady of Fatima School: Suburban Catholic school located in York Region. Most of the students are of European background, although this is changing with the arrival of new immigrant families to the area.

Grade 5: Cathy's Story

Cathy had been teaching in the York Catholic District School Board since 1992, beginning as a kindergarten and ELL teacher, and then focusing on the Junior grades. She was keen to introduce Inquiry to her students because she wanted them "to take ownership of their learning and be critical thinkers". She also wanted to better understand the Inquiry approach.

Cathy initially felt nervous and a bit confused about how things would unfold. She worried about reporting timelines, how to engage the students, and whether her class would benefit from this new teaching and learning approach. She admits that she struggled to understand her role as a teacher and the process of "letting go". Likewise, the students found it challenging at first. They were nervous and unsure about how to participate or share their ideas.

By the end of the year, both Cathy and her students had found their way. As Cathy had hoped for, the students took ownership of their learning and she felt more confident about her role in this process.

Focus of Inquiry: Alternative Energy Sources

Starting the Environmental Inquiry Process

The Grade 5 class began asking questions about energy conservation even before Cathy had planned to address this topic in her long-term plans. The students' interest in energy conservation came about during their inquiry into the roles and responsibilities of different branches within government, which occurred in the wake of the 2009 United Nations Climate Change Conference in Copenhagen. The media coverage of this event was intense and pervasive, and soon caught the attention of the Grade 5s. Students came into class with questions about the Summit: "Who's there? What are they doing there? What are they talking about?"

Cathy had not planned to integrate Government and Energy Conservation. However, she was willing to rearrange her plans to accommodate and honour her students' curiosity. As well, she recognized that this shift in interest presented an opportunity to integrate knowledge from a different subject area in a way that would support the students' emerging

understanding of how governments function. Indeed, "knowledge building is not confined to particular occasions or subjects but pervades mental life–in and out of school" (Scardamalia, 2002, p. 11).

To spark student questions and generate a class discussion, Cathy brought in an online article on climate change, projecting it onto the classroom data projector for the students to read. The article generated numerous questions among the students: What is climate change? What is global warming? What causes it?" It also elicited ideas: "It means the Earth is getting warmer. It's caused by greenhouse gases…air pollution…litter…CO2 emissions… cars…electricity…" And it sparked a conversation about alternative energy uses and the sources of energy used to power hybrid cars.


TORONTO STAR

Star joins global climate crusade

By the time the Grade 5 inquiry into Government drew to a close, Cathy felt confident that the class was more than ready to move forward with Energy because they were already curious about and familiar with the topic. To help the students make the transition to Energy, she reminded them of their discussions about energy conservation from the previous inquiry into Government, and suggested that they might want to explore this new topic more deeply: "What do you wonder about energy? What would you like to find out more about?"

Cathy asked the students to each write his or her question on a Post-it note. She realized, of course, that the class would end up with nearly 30 questions to organize and address. Although she knew these would provide her with useful information about what each student was interested in and how they expressed their curiosity, how would she (or any teacher) manage to address so many questions? Where would she even begin?

As Cathy learned, the answer to this question is threefold:

1. The teacher does not necessarily take sole responsibility for organizing the students' questions.
2. The students do not pursue every question they ask.
3. The students' initial questions constitute the 'raw material' of their critical thinking processes. With the teacher's guidance, through KB Discourse, and small-group discussions, the students narrow down and refine their questions.

Question sorting

Cathy kept these three principles in mind. She reconvened the class for a period of Knowledge Building Discourse, a forum in which children are encouraged to share their questions with the whole group (See page 11), and used this opportunity to begin the process of 'question sorting'.

Cathy began by asking one student to share his question aloud and to place his Post-it note on the board. Next, she asked the other students to consider whether their questions were connected in some way with that first question that was placed on the board. Those students who saw a connection repeated what the first child had done, reading their question aloud, in turn, and placing their Post-it note on the board, next to the first one.

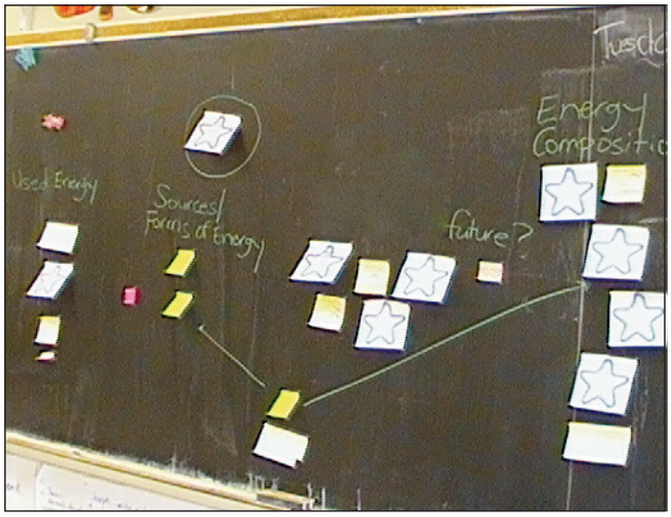


Photo 92: Sorting and Categorizing Students' Questions

Then Cathy asked: "Does anyone have a question that is not related to those in this cluster?" A number of students felt this way. The first among them to read aloud an unrelated question knew exactly what to do. She positioned her Post-it note apart from the others on the board to indicate that her question belonged to a different category of questions. Soon, other students were following suit, and a second cluster of Post-it notes was formed.

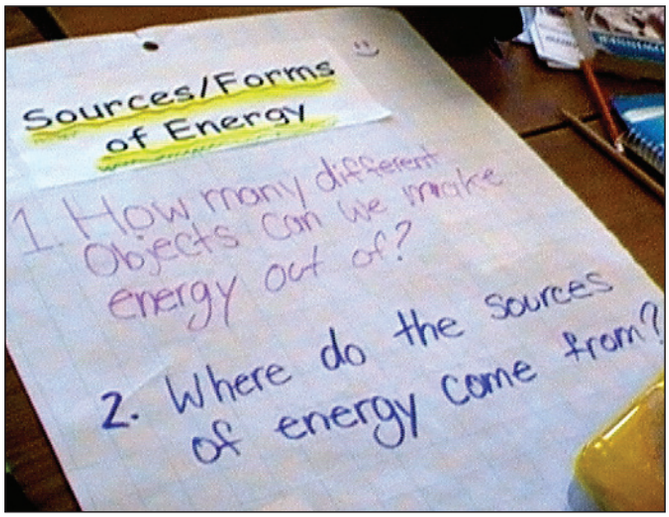
Next, Cathy asked her students to consider why the questions in each cluster of Post-it notes were related and to think of a representative title for each category. After some negotiation, the class agreed to label the first group Used Energy and the second, Sources/Forms of Energy. This process continued until every student had added his or her question to the board, resulting in the creation of two more categories: Future of Energy, and Energy Composition (See Photo 92).

The students discovered that there was more than one possible category in which to place their questions and that the question "What is energy?" related to all of the categories. They all decided to investigate this overarching question, in addition to questions that were still being refined.

The Grade 5s formed interest groups of approximately four to five students. Each interest group chose a category of questions to pursue together, re-examined the title of their category, and transformed it into a question, which they wrote on chart paper. The class investigated each of these new questions in small groups, in addition to the overarching question: "What is energy?"

Ongoing question refinement

As the research process evolves, it often becomes necessary to refine existing queries and emerging ones. Students may need to re-craft their question after they have already begun their research, as was the case in Cathy's class. A group that was investigating the question "Are there sources of energy in outer space that can be used in the future?" had difficulty finding accessible information on this topic. They decided to refine the scope of their question to: "What are possible energy sources in the future?"



Students' questions can sometimes stray too far from the "big idea" or overriding question. In such instances, it is perfectly appropriate for the teacher to refocus the students' attention, as Cathy did with a group investigating "How can energy be a danger to the world?" At one point, the group's research seemed entirely focused on bombs and explosions. Cathy asked the students to identify, from their research thus far, which kind of energy was, in fact, 'dangerous'. The group cited nuclear energy because of its potentially explosive consequences. Cathy asked for clarification: "What exactly did you mean by the word danger?" This led the students to think more in terms of negative and positive effects instead of focusing on explosions. The students' new question became: "What are the advantages and disadvantages of nuclear energy?" (See Table 23).

Table 23: Evolution of Children's Question Refinement

Collective Research Question: "WHAT IS ENERGY?"	
INITIAL SMALL GROUP RESEARCH QUESTIONS	STUDENTS' SORTED AND REFINED QUESTIONS
"Where do sources of energy come from?"	"Where do sources of energy come from?"
"How do they make electricity in power plants"?	"How do they make electricity in power plants"?
"How does energy on Earth compare to energy in outer space?"	"What future sources of energy will there be?"
"How can energy be a danger to the world?"	"What are the advantages and disadvantages of nuclear energy?"

As children research and encounter new information, they inevitably have more questions. Students who were investigating the question "What are the advantages and disadvantages of nuclear energy?" also wondered "Should we use nuclear energy or not?" and "What is the government of Ontario doing with nuclear power plants?" Students who wondered "How do they make electricity in power plants?" also investigated "How does water turn into electricity?" and "What alternative sources are there to generate electricity?"

Integrated Learning

Connecting the learning through flexible planning

Cathy's use of her students' questions to re-think her long-term plans is important in terms of program integration considerations. Integrated Learning is not necessarily limited to the simultaneous teaching and learning of multiple subjects. Integrated programming can also occur when meaningful links are made from one subject area to the next, so that disciplines are represented as a cohesive whole, rather than disconnected parts having nothing to do with each other. If students are able to make these links themselves, as the Grade 5s did in Cathy's class, their learning will be even more meaningful. For this to occur, however, teachers need to continuously pay careful attention to the direction of students' comments, and juxtapose those with their long-term plans in order to assess whether rearranging previously made plans would make for a more authentically holistic learning experience.

Developing critical reading and research skills

In the Junior years, students generally transition from the 'learning to read' stage to reading for purpose and information. This reading stage entails the development and application of fundamental skills – researching, synthesizing, and questioning the content in a variety of resources. The ability to access, critically assess, and effectively communicate information and ideas can serve to inform an individual's knowledge and understanding of the world, both during the school years and throughout adulthood.

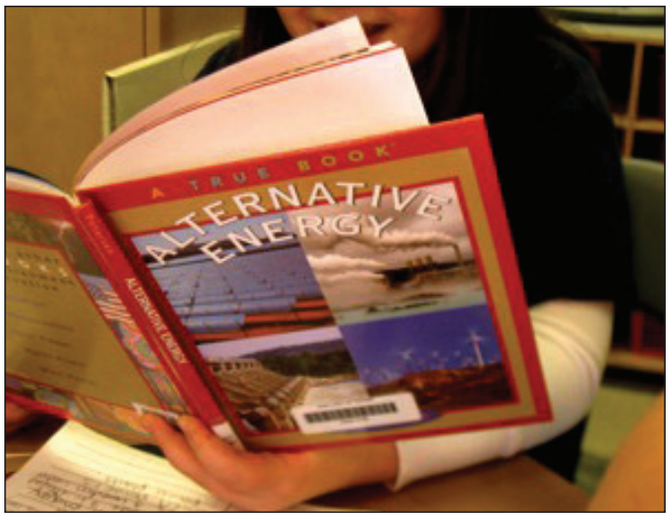


Photo 93: Researching Authoritative Sources

Cathy recognized that the Grade 5's inquiry into Energy was an ideal opportunity for her students to apply their reading and research skills. Facilitating this opportunity would also fulfil the Ministry's curriculum expectation, which states that students "need to be able to think critically, to see things from many different perspectives, and to use all of the information available to make informed and reasoned personal choices about energy use and conservation" (2007b, p. 107).

When students are researching a question that genuinely interests them, they are more motivated to read. They are looking for specific information that will help them better understand an issue or answer their question. However, students need to learn how to read critically, to discriminate between relevant and irrelevant information. Cathy knew that not all of her students had mastered these skills, particularly when the content contained vocabulary and concepts they had not previously encountered. And so, she provided her students with opportunities to learn about and practice specific skills that would pave the way for a successful research experience.

Selecting relevant information

Cathy provided an opportunity for the class to discuss various strategies for selecting relevant information. She displayed an article about energy on the overhead projector and modelled examples of 'think-aloud' questions that could help them distinguish extraneous information from pertinent: "Does this statement relate to my question? Do I need to know this in order to understand my question? Why is this important information to know?" The students engaged in an interactive discussion in which they defended their decisions about the relevance of the information they had selected to answer the question "What is energy?"

Cathy asked the children for suggestions about how to summarize and paraphrase their research information into brief jot notes. Following this modelling, the children then practised this skill by analyzing the article for themselves and writing their own jot notes in their Inquiry Lab Books.

Consulting a variety of sources

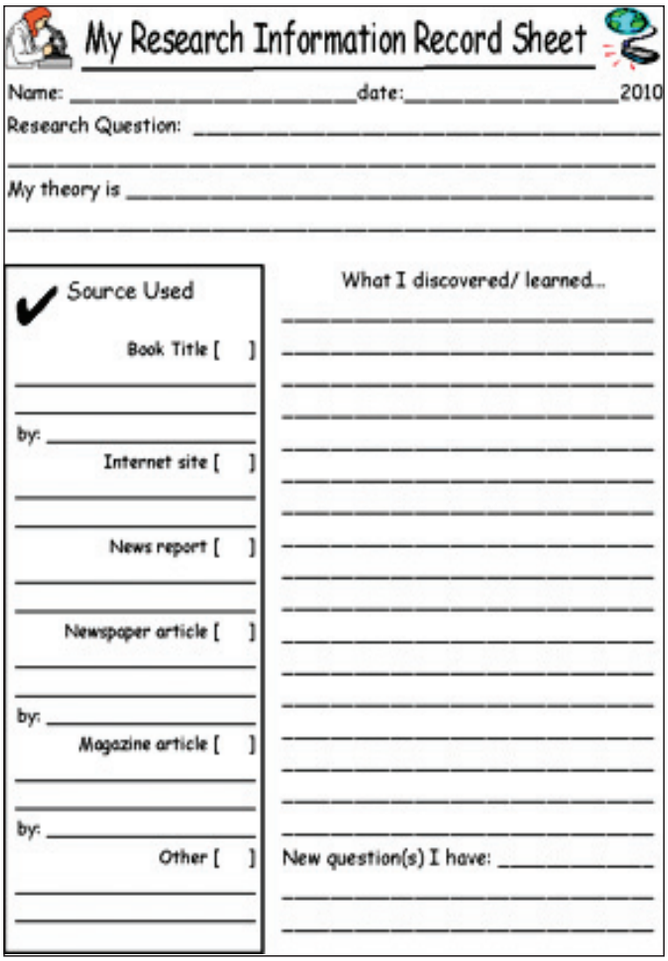
Cathy wanted to ensure that her students understood the importance of consulting a range of research materials before they began their small-group research. She brought to class a range of age-appropriate library books on topics related to the students' questions, which facilitated a class discussion on the relative merits of different resources compared to others. The class talked about how some books provide less useful information and pictures than others. They also discussed how expert opinions about a particular issue can differ depending on the resource. For these reasons, Cathy brought her students to the school library so they could consult various resources for themselves. Cathy also brought the Grade 5s to the school's computer lab to conduct online research. Through ongoing Knowledge Building Discourse, the students explored new questions and theories in light of recent research, well in advance of their oral presentations to the class.

Sources of Research in the Grade 5 Energy Inquiry

- A wide variety of books, magazines, news items
- Web resources
- Field experiences
- Experts in the field
- Knowledge Building Discourse

Documenting research

To help the students organize their research, Cathy provided a template for each student to document their research question and their theory. The template also provided a space for students to write brief jot notes, indicate the source of their research, and record any new questions that might have arisen (See Photo 94).


My Research Information Record Sheet

Name: _____ date: _____ 2010

Research Question: _____

My theory is _____

✔ Source Used

Book Title [ ]

by: _____

Internet site [ ]

News report [ ]

Newspaper article [ ]

by: _____

Magazine article [ ]

by: _____

Other [ ]

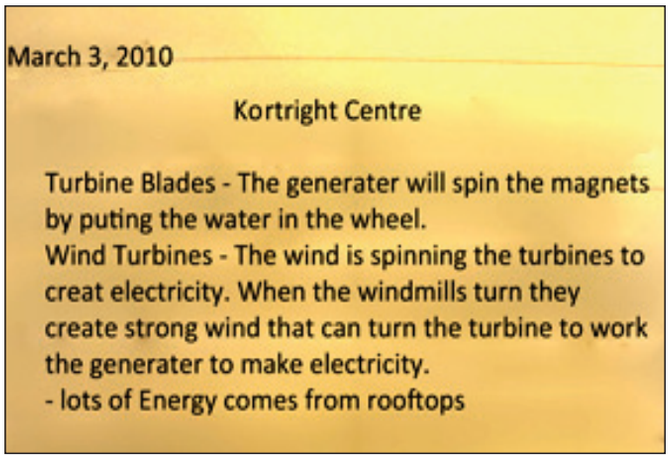
What I discovered/ learned...

New question(s) I have: _____

Photo 94: Research Record Sheet

> *"We don't have Science. All we have is Knowledge Building!"*
> – Grade 5 student

The students were soon gathering so much research – from books, Internet sources, Knowledge Building Discourse, experts, and from their filed trip to the Kortright Conservation Centre – that it made sense to consolidate their research in one place: their Inquiry Lab books. The Lab Books not only served as a repository of research information, they served to document each student's growth in the research process.


March 3, 2010

Kortright Centre

Turbine Blades - The generater will spin the magnets by puting the water in the wheel.
Wind Turbines - The wind is spinning the turbines to creat electricity. When the windmills turn they create strong wind that can turn the turbine to work the generater to make electricity.
- lots of Energy comes from rooftops

Photo 95: Jot Notes taken during trip to Kortright*

* Text enhanced to ensure legibility. Original grammar has been maintained.

Knowledge sharing

An inherent risk in small-group research is that each group may focus on their own research project and not learn about the research of the others. This is precisely why frequent Knowledge Building Discourse is so critical to the research and learning process. As the Ministry of Education notes, "Real, purposeful talk is not only an essential component of the language curriculum; it needs to be threaded throughout every day and across the curriculum to promote the transfer of language knowledge, skills, and strategies to learning across the curriculum" (2006, p. 77). Through Knowledge Building Discourse, students have the opportunity to contribute to each other's learning by sharing information and exchanging opinions and ideas.

Cathy wanted her students' experience of Knowledge Building Discourse to be a positive reflection of who they were as learners, one that would enable them to see themselves and one another as valuable learning resources. She also hoped to engage their attentive listening skills in the process. To accomplish these goals, Cathy asked the students to bring their Inquiry Lab Books to each Knowledge Building Circle and use these books as a two-way information resource. Students could consult their own jot notes when presenting information to the larger group, as well as make jot notes of other students' presentations that could be relevant to their own research and interests (See Photo 96).

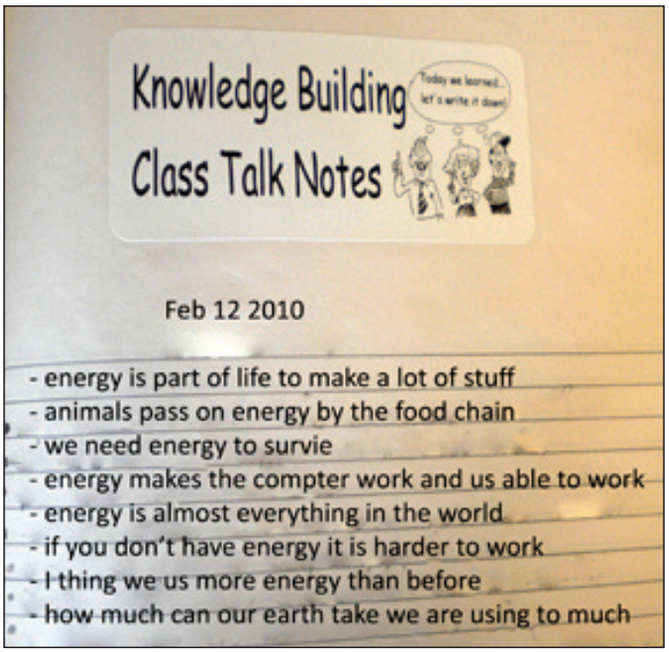


Photo 96: Jot Notes from a KB Circle*

* Text enhanced to ensure legibility. Original grammar has been maintained.

Using Wiki

Cathy created a Wiki site for her class that served to extend the possibilities of Knowledge Building Discourse about issues of energy conservation. A Wiki allows users to collaboratively create and edit web pages using a web browser. Each research group had their own interlinked subpage page on the Wiki site, which included their question, initial theories, research information, and new ideas or questions.

> *"What was amazing to see was that kids were beginning to write on each other's Wiki pages! This thrilled me. The children were knowledge building!"*
> – Cathy Bertucci, Grade 5 teacher

The students began contributing to their subpages by adding the information they had recorded in their Inquiry Lab Books. Whenever the class had the opportunity to access the school's computer lab, they added more research and ideas from their Lab Books onto their Wiki pages. Cathy encouraged the Grade 5s to explore each other's subpages for information that could be helpful to their own question. Students were soon accessing information from other groups' subpages and making jot notes in their Lab Books! This was especially helpful to students who needed more time than a Knowledge Building Circle would allow for making jot notes. They also began to make contributions directly onto each other's Wiki subpages with information that they believed might be helpful to another group. The students were literally building knowledge!

> *"I felt I had enough information about what the kids had learned, and how they learned, that I didn't need to give them a "final" test for reporting. They presented often; they posted on Wiki; they shared within their group; and I was on top of their researching on the computer and in books. I felt that I could confidently support what I gave as a grade without a "test". Wow! I've never done that before."*
> – Cathy Bertucci, Grade 5 teacher

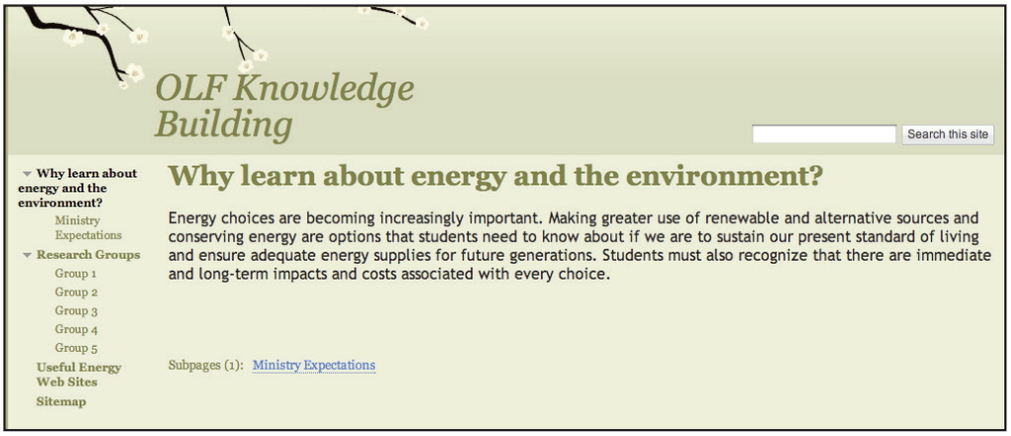


Photo 97: Grade 5 Energy Wiki Home Page

Are some of the sources of energy ECO-friendly?

Initial Theories:

Cristian: I think that some of the sources are eco-friendly, such as wind energy and turbines; solar energy - there is no waste from it. the problem is that the batteries that sola power is stored in are heavy.
Alex: hydrogen - is eco-friendly gas - doesn't pollute; easy to make;
Philip: I think that most of the renewable sources of energy are eco-friendly: sun; wind; water; hydrogen.
Liam: I disagree with wind turbines being eco-friendly because trees are cut down and there is noise pollution.
Justin: I disagree with Liam because if we need more space for turbines, we don't have to put them in a forest, we can put them in a meadow, we don't have to cut down trees.
David: I disagree, because when we went on the trip, the man showed us that the wind turbines have a different set of blades and it didn't make any noise.

Important Information We Found in our Research: March 11, 2010

Sieana: Nonrenewable energy releases greenhouse gases which are linked to global warming.
Meghan: Solar energy uses the energy from the sun in 2 ways to generate heat and to directly convert the suns energy for electricty.
Olivia: Solar, wind, hydropower energy is ECO-friendly.
Sofia: The sun is eco-friendly by using the sun light for heat.
Sienna: Fossil fuels-petroleum, natural gas and coal were accounted for 85% of the energy used in the united states in 2008.
Olivia: Fossils fules such as coal and gasoline provides most of the energy needs for the world,today.

Important Information We Found in our Research: March 29, 2010

Sienna: There re 11 types of energy. For example: potential, kinetic, chemical, radiant, nuclear, thermal, stored mechanical, motion, gravitational, sound and electrical.

Photo 98: Knowledge Building on the Wiki

Cathy's Final Word

"We must give students the opportunity to think for themselves, to critically question things and investigate. We can't expect them to give level 4 answers if they haven't experienced level 4 discussions.

By the end of the year, my students were actively engaged in seeking out information. They were excited about taking on a question and seeking information through various sources. They asked questions that extended beyond the "Who, What, Why, How?" They related to self and the world."

Conclusion

This resource serves as a guide for you, the teacher, seeking a powerful way to make both the content and process of learning about the world more engaging and relevant for your students. This change is possible when students become personally invested in a process that is shaped by their very own questions and theories about the world – their natural curiosity – and a process that places them in direct interaction with the local natural environment. This is Environmental Inquiry at work.

Teachers who have embarked on this journey know the benefits of this approach. In Environmental Inquiry, students deepen their understanding of the earth's interconnected systems through ongoing discourse and reflection in pursuit of idea improvement. They feel secure about their ability to take intellectual risks, to question, to contribute to community knowledge, to think out loud, to think. A learning process that places this much value on students' ideas is transformative, empowering students to translate their knowledge, sense of agency, and appreciation for the natural world into stewardship behaviour.

Change can be both exciting and unnerving. Yet, nothing worth doing is ever easy or instantaneous. Reforming long-established teaching norms, both at the individual and systemic level, will take time. It will likely involve some trial and error and a period of adjustment. This is a natural part of the transformation process. What is important, however, is that we start the process now.

Environmental Inquiry is based on a transformative vision of education, one that seeks to develop not only skilled and knowledgeable students, but also, environmentally and socially-conscious world citizens. It is a sustainable movement that fosters an inclusive learning experience for all students. Achieving environmental sustainability is critical to the social and economic wellbeing of us all and is arguably one of the greatest global issues of the 21st century. Given the vulnerable state of our biosphere, the time for change in all facets of life, especially in education, has come.

As a teacher, you may well be asking. *"Is Environmental Inquiry really a 'do-able' model for elementary teachers in public schools?* Is this kind of fundamental change actually possible?" As the public school teachers profiled in this resource unanimously agree, the answer to such questions is a resounding, *"Yes!"*

Pedagogical absolutism is not necessary. Each of these teachers began the process in a way that made sense for them and for their students. Starting out the process with small, simple steps is considered both 'okay' and beneficial. Try Environmental Inquiry with just one unit; bring your students outside; ask them what they wonder; ask them what they think; facilitate a Knowledge Building Circle. Teachers who have tried this approach only began to internalize the principles of Environmental Inquiry after experiencing it for themselves, much like their own students did. *"As we got going,"* reflects Kathleen Quan, *"the class was so engaged, enthusiastic and productive that I was able to relax and keep the big picture in mind."*

As these teachers engaged in progressively deeper levels of Environmental Inquiry with their students, they discovered that their initial trepidation over such issues as curriculum coverage and assessment requirements were unwarranted. As Cathy Bertucci experienced, these elements of teaching are embedded throughout the process of Environmental Inquiry: *"We covered the Big Ideas set out in the Ministry guidelines in a deeply authentic way, without having to move through the curriculum as if it were a checklist. Assessment and reporting were alive and present – giving feedback was immediate – which helped move the students' learning forward."*

In sum, the teachers who embarked on this journey of Environmental Inquiry are happier, invigorated and inspired. *"There's a much higher level of student engagement in the Environmental Inquiry process,"* says Kathleen. *"It's more interesting to me and more fun. Also, it's more relaxing to know that kids are interested in what they're doing. It's just a nice feeling for a*

teacher." Their transformed practice has not only significantly enhanced their students' learning and development, it has given these teachers a greater sense of agency as educators who are unique, creative and responsive to their students' needs. *"At the beginning of the inquiry process I felt very confident and assured,"* recalls Kathleen, *"but then I realized that not only was the class undergoing a shift in the way they were learning but I was also changing."*

Like their students, these teachers have become empowered because they have experienced the benefits of Environmental Inquiry, for themselves and their students. Confident and purposeful, they take intellectual risks, challenge old thinking and habits, and make sound pedagogical decisions based on their own professional judgement. Moreover, these teachers have developed analytical skills that enable them to make the curriculum as accessible and meaningful as possible for their students. They are reflective practitioners in the truest sense, who have the confidence and good judgement to question, to think out loud, and to contribute their own experiences for the benefit of other teachers and the professional community at large.

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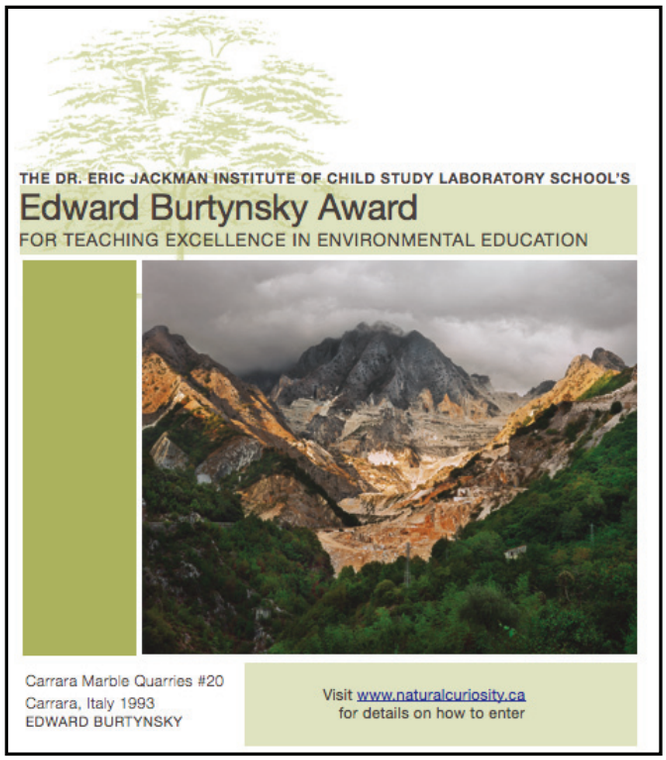
Appendix

The 2010 Edward Burtynsky Award for Teaching Excellence in Environmental Education

The Edward Burtynsky Award for Teaching Excellence in Environmental Education was established in 2009 by The Laboratory School at the Dr. Eric Jackman Institute of Child Study. It was made possible by the Norman and Marian Robertson Charitable Foundation, world-renowned photographic artist, Edward Burtynsky, and several anonymous donors.

This annual award was created to recognize and celebrate outstanding elementary school teachers in the province of Ontario who, through exemplary teaching methods, create learning opportunities that inspire students to become environmentally conscious, responsible world citizens.

Elementary school teachers from across Ontario were invited to submit an application for this prestigious award describing, through practical examples, their commitment to Environmental Education. The stories comprised in this Appendix are those of the inaugural award recipients: The staff of the Belfountain Public School, David Barnes of Oscar Peterson Public School, and Tawnya Schlosser of Hillcrest Central Public School.



For complete application details for the Edward Burtynsky Award for Teaching Excellence in Environmental Education, please visit www.naturalcuriosity.ca.

Grand Prize

Whole Staff: Belfountain Public School – Caledon

Written by: Bryan Bibby-Smith, Janice Haines, & Lynn Bibby-Smith

How does vermi-composting, invasive insect species, and the scientific method become a meaningful learning experience for a class? It all began with a bin full of worms. Three years ago, the students and staff at the Belfountain Public School, nestled away in the hills of Caledon, Ontario, initiated a vermi-composting program. It was just another slice that makes up the whole of their E.C.O. school program (Environmental, Conservation and Outdoor Education).
The worm castings, or worm poop produced was great for the school's gardens, but could it translate into a grade on a report card? That question lead the teachers to look at their curriculum not in terms of units, with clearly defined beginnings and ends, but rather from an inquiry-based approach. It all starts with a question.

The school gardens are thriving and the worms are happily composting, now what do we do with all of this worm poo? The grade four class took the lead. They researched its benefits, problem-solved how best to prepare and package it, corroborated with the School Community Council to promote it and finally used marketing skills to sell it as a school fund-raiser, collecting money for a schoolyard greening project. And all of their hard work was assessed and recorded by their teacher.

Wanting to include members of this close-knit community in the decision-making process for the schoolyard planning, partnerships were struck with the school community council, the CVC (Credit Valley Conservation), the Ontario Stream Organisation (is that its name?), and the Ministry of Natural Resources. The junior classes developed planting plans, assessed the areas to be planted and researched the native tree and bush species that would populate their yard. One such species is the Ash tree; a species at risk due to the invasive Emerald Ash Borer. The forester from the CVC encouraged the students to reduce the total number of Ash trees and to spread them out, to prepare for the possibility that these trees may die.

In the fall of 2009, the tree planting took place, with all the children involved from grades Kindergarten to 6, along with the staff and many community members. Everyone celebrated the accomplishment and recognized that the planting is a stewardship commitment. No cut zones were established, tree guards put on, coir mats placed and necessary watering was done. The children at Belfountain had a beautiful school yard, but was that it? Not even close. Another student asked a question: what could be done to pro-actively help protect the trees from invasive insect species?

Back to the worms. A discussion in the class promoted a student to remember that the compost 'tea' produced by the vermi-worms helped to deter insects. Students went home and consulted parents and grandparents, relatives, and neighbours for their ideas, formulas and, recipes for dealing with destructive bugs on plants. Back at the school, they broke off into small groups to collaborate on their ideas, make some decisions and develop a

plan to combat the Emerald Ash Borer. The ideas included the use of compost tea, coffee grounds, rosemary, vinegar and garlic among others. The students then researched the life cycle of this insect to learn when it might be best to apply the formulas they had developed to interrupt the life cycle and prevent the spread of the invasive species. When designing the experiment, using the scientific method, the students had to consider the frequency of application, the time of day, weather conditions and how to observe and record any changes to the tree. Each group had a different approach to deal with the experiment.

Near the end of the school year, the teacher shared an article about Professor Sandy Smith's research occurring at the University of Toronto. Dr. Smith is studying the possibility of using native species of insects to control the spread of the Emerald Ash Borer. Students sent Dr. Smith emails and as a result, Professor Smith will be visiting these students this fall to share their findings and their progress. This stewardship project belongs to this group of students; it doesn't stay with the teacher. Therefore, it will be their grade five teacher who will be welcoming the Professor to the classroom. Just as in real life, learning doesn't always fit into neat, two-week units. Longitudinal studies over grades can develop, making learning rich and personally meaningful.

Inquiry and curricular integration are the vehicles to successfully combine these diverse learning opportunities. Seize the teachable moments over the course of the year to make real life connections, develop important questions, create plans and conduct research and experiments. Along the way, the process for these children helped to create a sense of stewardship for the schoolyard and for the broader community.

So again, where's the curriculum? Remember, it all started with worm castings. From there, students' work included measuring, research, artwork, computer graphics and oral presentations. They used effective and persuasive language in their Poop to Go marketing campaign. The schoolyard greening project propelled tree identification, research, summation skills, and oral and visual presentations to their classmates. They also measured the perimeter and area of the yard and made adjustments for spacing necessary between different species. They mapped and measured existing greenery on site. In small groups they created bird's eye view, colour-coded, scaled and keyed maps. Based on the parameters given by the forestry expert, they then debated and voted on a single map for the actual planting. Looking for still more curricular connections? The grade fours have grade one learning buddies. The senior students created songs and developed short presentations to help the younger ones learn and remember the names of the different tree and bush species. The opportunities are almost endless, all beginning with a single question. Further questions or inquires are now the business of next year's teacher to facilitate, as the students are keen to follow up with this project to ensure the survival of their trees and shrubs.

Worm poo and the Emerald Ash Borer. Who could have predicted what would motivate and excite grade four students into earnest and rewarding work? The inquiry based approach puts the ownership and responsibility on the children and can make them contributing members to their community right now. As the role of facilitator, you the teacher simply grasp those teachable moments, apply the appropriate curricular skills and hang on for the ride.

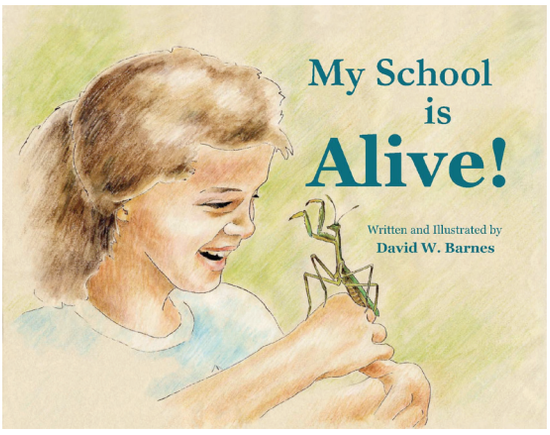
Runner Up

David Barnes: Oscar Peterson Public School – Mississauga

Written by David Barnes

"It all began one spring morning when my grade two teacher decided it was time to go outside for a walk around the schoolyard. We trudged outside all the way to the middle of the field and then sat in a circle around our teacher. Mr. Barnes smiled at us and said, "I've got a very important task for all of you this morning. Your job is to find as many different kinds of living things as you can. Search everywhere, on tree trunks, under stones, on leaves, in the grass and underground. The most important thing to remember is to always be gentle with what you catch. All living things are to stay living and all will be set free at the end of the day. I hope no one is afraid of getting their hands dirty!"

– Excerpt from *My School is Alive!* (Barnes, 2001)



Based on my personal experience, My School is Alive! is a children's book that tells the true story of how the creation of a garden changed a fundamental way of thinking throughout one elementary school. Narrated by Sara, a grade two student, the story follows a school's journey of cross-curricular explorations and discoveries using the garden's living elements. I authored and illustrated this book as a tool to help teachers create learning experiences that lead to student growth in eco-literacy.

Just how well prepared will our children be? The term "eco-literate" is often used to describe people who understand and care about the environment. My School is Alive! presents a practical example of eco-literate teaching and learning at work, and is based on a specific criteria that I have created to build and assess eco-literacy in my students called KAFA. Each component of KAFA is defined as follows:

- **K**nowledge of the earth (toward a deeper understanding)
- **A**ppreciation for the earth (toward respect for all things)
- **F**eelings for the earth (especially that of empathy)
- **A**ction for the earth (toward future change)

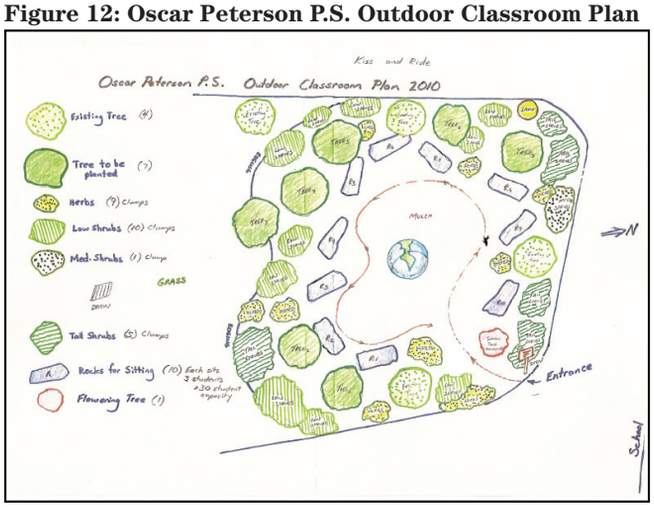
Knowledge: For me, the knowledge component of eco-literacy has become a link that connects all areas of the curriculum in the students' minds. For example, butterflies are used in my class to teach symmetry in math. As the students are given the opportunity to observe and draw butterflies, they become aware of the beauty and intricacy of the symmetrical designs and colours. From that moment when they see a butterfly in the park, they will think about symmetry. And, when they see a math question regarding symmetry, they will think about butterflies. Knowledge of the earth can become a powerful teaching tool to enhance curriculum instruction by inspiring students and building lasting connections.

Appreciation: In my experience, I have found that children learn more and connect personally to other living creatures when they can actually observe and interact with them. This is why I always look for opportunities to bring my students outside to search for living creatures on the schoolyard as illustrated in My School is Alive! If I want my students to appreciate butterflies, I bring them outside to watch insects on the school field. The students may even care for butterflies in the classroom. This experience enables the children

to observe the delicate wings and feel the joy of releasing living creatures into the world.

During my first year teaching, I used to watch the children at recess squishing worms for fun that had crawled helplessly onto the pavement. Over the next few years I worked with the students to bring the schoolyard to life by creating a nature garden. This project became a school-wide initiative. The nature garden provided students with a diversity of motivational experiences (e.g., growing trees and butterfly plants from seed; taking care of insects; tending a butterfly garden, etc.). The project provided children with the ability to touch, hold, feel and nurture living things. After the project's fifth year, a group of students approached me at recess gently cradling several handfuls of wriggling earthworms that had been rescued from the pavement. With urgency in their voices, they asked permission to return the worms safely to the soil in the nature garden. As I looked around, I could not find a single student squishing worms for fun. All I could now see were children who had come to appreciate and respect the lives of other living things. To further cultivate even more appreciation for the earth, our school is raising funds to build an outdoor classroom (See Figure 12).

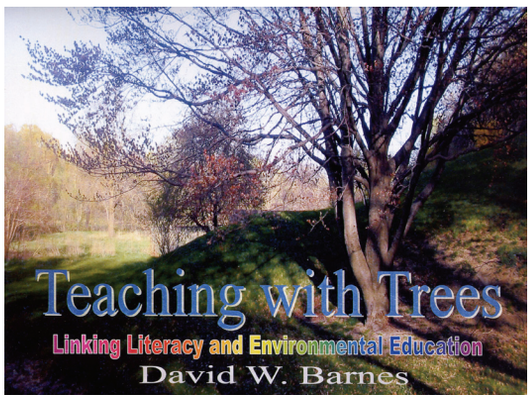
Figure 12: Oscar Peterson P.S. Outdoor Classroom Plan



Feelings: Feelings are the next natural response to an experience following appreciation. Humans naturally exhibit feelings, but it is often difficult for children to find the vocabulary to verbalize how they feel. Teachers can help this process by introducing and modeling the use of feeling words to express emotion. I try to move beyond basic words such as good, nice and happy, to words with a deeper meaning such as joyful, calm, peaceful, and thankful. In addition, teachers can provide sharing opportunities where students can practice their new vocabulary. Oral sharing also enables connections to be made with others which validates and transfers feeling into a child's long term memory. In this way, a teacher' role is to provide structured opportunities that assist children to articulate and validate their feelings.

Action: One of our school's environmental "action" initiatives was the creation of an organic vegetable garden. Students gained the knowledge that healthy food was a basic need of all living creatures. They also explored the problem that many foods available to them were not healthy. In addition, the children learned that even many healthy foods such as fruits and vegetables were grown using harmful chemicals.

I frequently asked the students how growing healthy food made them feel. The students told me that our garden's salad is the best they have ever tasted. Some said they felt thankful for not being hungry like other kids in the world. Others said they felt happy that growing food without chemicals would keep other garden creatures healthy. Most said they felt really excited to start growing more food. In a few years, the older students will be empowered to teach the younger students these skills!



Teaching with Trees: Linking Literacy and Environmental Education is a teaching manual that outlines a program for teaching the most common writing forms (reports, expositions, procedures, explanations, letters, recounts and

narratives) linked to the experience of growing trees at school. The manual is complete with student black-line masters and assessment rubrics. It is an easy way to begin implementing eco-literacy as part of your writing program.

To receive more information or to purchase copies of the children's book, *My School is Alive!* or the teacher's manual *Teaching with Trees: Linking Literacy and Environmental Education*, you may e-mail your request to paletteofdreams@yahoo.ca.

Runner Up

Tawnya Schlosser: Hillcrest Central School – Teeswater

Written by: Tawnya Schlosser

In my present school I am known as the "creature teacher" because of my love of animals and the fact that we have live creatures in our classroom. I have always tried to ensure that the students in my class learn in an inquisitive, hands-on way, and I love to do learning outside as much as possible. Five years ago I joined the Monarch Teacher Network where I gained the skills to bring the environment into my classroom in a deeper and more meaningful way. This is where my specific work in Environmental Education really took off.

Every year, on the first day of school, I have monarch caterpillars and chrysalides placed around the classroom. When the children walk in they are quick to start asking questions about what they see. They are fascinated with which end of the caterpillar is the head and which is the tail, and how I put the "glitter" on the chrysalis. The best part of that first day is when a Monarch butterfly emerges from its chrysalis. You could hear a pin drop as the students stare in rapt excitement watching this new life begin! We also have different kinds of milkweed, magnifying glasses and microscopes accessible to allow students to make detailed observations. Everyone has a journal that they can record their observations, measurements and questions, and I model using this journal myself. The first week of school my students are also introduced to the school's butterfly garden, which our class cares for throughout the year. As the boys and girls smell, touch and study the plants that are growing, they get to ask more questions and work together to try and find the answers.

Once the students recognize the features of milkweed plants, we spend some time at the back of the schoolyard identifying and checking milkweed for eggs and caterpillars. This helps students to have the skills to recognize and hopefully preserve milkweed at their own homes and in the community.

At the end of September my students prepare for a butterfly release party. They create wings for themselves to wear, and we practice a song and some facts to explain to our audience. We parade around the school picking up the entire student body and then head out to the garden. We sing our song, explain our facts and put a butterfly or two on some teachers' noses. When all of that is complete, we open the top of our butterfly cage and release them on their journey to Mexico. It is very exciting! Later in the fall my students work in the garden to prepare plants for the upcoming winter. They trim the dead perennials and place leaves around some of the more sensitive plants. They also remove weeds and garbage.

The monarch butterfly project easily lends itself to integrated learning. All of our language activities revolve around Monarchs. Students have the opportunity to read and listen to a variety of non-fiction texts in book, Internet and DVD forms. I also use a number of different fiction stories for read-alouds and guided reading activities. My students engage in written activities such as recording observations, writing reports and narratives. As the Monarchs migrate to Mexico each year, my students "go" with them. Through the Internet and the website "Journey North", my class is able to track the monarchs' journey. For Social Studies, we learn about the people who live in the sanctuary region of Mexico. The students learn how the people are similar and different to us. One year we tried making bricks by hand by mixing clay, water and grass with our feet to see what it would be like to make bricks in rural Mexico. Later we learn how groups like Alternare are teaching the Mexican people new farming methods that are

more eco-friendly for people and for the butterflies. The students begin to see that all of North America is linked together and that we all need to cooperate to preserve this species and the planet as a whole. I also include the arts through teaching a variety of songs, learning plays and creating artwork from natural, found materials.

My students learn early that the garden belongs to them. They are in charge of caring for the garden and selecting annuals that will be included each year. Former students often visit the garden at recess and comment about how they have added some of the same plants to their own gardens at home.

My students have internalized the information that they learn. I remember the one day that we were working on the garden and a bumble bee buzzed past. In past years, most students would start shrieking and run, but to my surprise my students shouted, "Oh look! It's a pollinator!" and watched it go about its business. Another day I watched some Grade two boys scolding some Grade 8 students who were tearing milkweed out of the back of the playground. It was amazing to watch these much smaller students explaining why these plants were so necessary in our world.

My students continue to carry their care for the environment into other activities throughout the year such as taking charge of the recycling program at our school, and working to persuade other students to reduce lunch time garbage with plastic containers to help reduce their ecological footprint. My students leave my room feeling empowered in their abilities to make the world a better place.


HAMILTON
COLLEGE

Environmental Inquiry is a powerful, four-branch framework that combines **Inquiry-based Learning**, **Experiential Learning**, **Integrated Learning**, and **Stewardship** in a dynamic process. It is based on a transformative vision of education, one that seeks to develop not only skilled and knowledgeable students, but also, environmentally and socially-conscious world citizens. Achieving environmental sustainability is critical to the social and economic wellbeing of us all and is arguably one of the greatest global issues of the 21st century. Given the vulnerable state of our biosphere, the time for change in all facets of life, especially in education, has come.

This resource offers elementary school teachers clarity, reassurance, and options for putting Environmental Inquiry into practice. It serves as a guide for teachers who are looking for a powerful way to make both the content and process of learning about the world more engaging and relevant to their students. This change is possible when students become personally invested in a process that is shaped by their very own questions and theories about the world – their natural curiosity – and a process that places them in direct contact with the natural environment. This is Environmental Inquiry at work.

Teachers who make the shift to Environmental Inquiry are better able to guide their students along the path toward responsible citizenship because this framework has the innate potential to elicit children's curiosity about the world and to create a classroom culture of learning that is purposeful, fun, and responsive to students.

Engage a child's imagination, and his or her learning naturally blossoms. Do the same for the teacher, and his or her practice is transformed.

Natural Curiosity
A Resource for Teachers

Building Children's Understanding of the World through Environmental Inquiry

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