Capacity Building Series

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SECRETARIAT SPECIAL EDITION # 32

Inquiry-based Learning

ON TRANSFORMING WONDER INTO KNOWLEDGE

It was only by taking the time to thoroughly investigate and interrogate a topic through dedicated inquiry that a falling apple became inspiration for the study of gravity and was eventually formalized into the scientific notation $g = 9.81\ m/s^2$, or that through the imaginative process of pretending to ride a light beam that $E=MC^2$ was borne. Our goal as educators is to help students make this leap – from intuitive understandings and natural curiosity to knowledge creation – to a space where ideas can be transformed into formalized understanding and further questioning.

The Great Challenge of Education Today

As educators we are charged with the great challenge and responsibility of engaging students in learning so that they develop the skills and knowledge they need to function in today's world. Questions and concerns abound. How do we instill the skills and the values necessary to experience success in the present and in the future? How can we provide opportunities for students to move beyond being passive recipients of knowledge to become knowledge builders, capable of creative and innovative solutions to problems? How can we play a role in human progress by equipping our students with the requisite knowledge, skills and dispositions to solve the daunting problems of our age?

There is no one recipe for success. There are, however, some pedagogical approaches to transforming educational practice that seem better suited for the job than others. What follows is a review of the key characteristics of inquiry-based learning that offer promise in supporting students to become thoughtful, motivated, collaborative and innovative learners capable of engaging in their own inquiries and thriving in a world of constant change.

The essence of inquiry …

"Inquiry … requires more than simply answering questions or getting a right answer. It espouses investigation, exploration, search, quest, research, pursuit, and study. It is enhanced by involvement with a community of learners, each learning from the other in social interaction."

(Kuklthau, Maniotes & Caspari, 2007, p. 2)

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Why student led inquiry? Why now?

"If we are only teaching what we know, our children can only do as bad as we are doing, and this is the challenge we are facing – we have to go beyond it."

(Pauli, 2009, TEDx)

Inquiry-based learning is education at its best ...

Inquiry-based learning is an approach to teaching and learning that places students' questions, ideas and observations at the centre of the learning experience. Educators play an active role throughout the process by establishing a culture where ideas are respectfully challenged, tested, redefined and viewed as improvable, moving children from a position of wondering to a position of enacted understanding and further questioning (Scardamalia, 2002). Underlying this approach is the idea that both educators and students share responsibility for learning.

For students, the process often involves open-ended investigations into a question or a problem, requiring them to engage in evidence-based reasoning and creative problem-solving, as well as "problem finding." For educators, the process is about being responsive to the students' learning needs, and most importantly, knowing when and how to introduce students to ideas that will move them forward in their inquiry. Together, educators and students co-author the learning experience, accepting mutual responsibility for planning, assessment for learning and the advancement of individual as well as class-wide understanding of personally meaningful content and ideas (Fielding, 2012).

Although inquiry-based learning is a pedagogical mindset that can pervade school and classroom life (*Natural Curiosity*, p. 7, 2011), and can be seen across a variety of contexts, an inquiry stance does not stand in the way of other forms of effective teaching and learning. Inquiry-based learning concerns itself with the creative approach of combining the best approaches to instruction, including explicit instruction and small-group and guided learning, in an attempt to build on students' interests and ideas, ultimately moving students forward in their paths of intellectual curiosity and understanding.

Educator as Provocateur

Moving students beyond initial curiosity to a path of regular inquiry is one of the great challenges of inquiry-based learning. In this process, educators play an important role. Teachers model how to contribute and extend ideas, how to question and how to carry out an investigation of one's ideas or theories. They play the role of "provocateur," finding creative ways to introduce students to ideas and to subject matter that is of interest to them and offers "inquiry potential" or promise in terms of opportunities for students to engage in sustained inquiry of their own. Further, while individual and small groups of students might choose to take a different approach to a particular overarching question in the classroom, it is the teacher who establishes a classroom culture in which ideas triumph as "central currency" and class members come together on a regular basis to discuss each other's learning. Through hearing others' perspectives, students come to a better understanding of their own ideas and approaches to questions and problems.

Student as Member of a Responsive Learning Community

All students are capable of contributing to a collaborative inquiry. For example, while some students might find it easier to ask questions and clarify other students' responses, others are more likely to provide overarching theories, making connections between the "big ideas." Although all contributions help in moving the inquiry forward, it is important to recognize patterns in the quality of contributions made by both individual students and the class as a whole.

Educators may need to encourage students to be flexible in their response type. For instance, if it is noticed that some students choose to simply agree or disagree with other responses, encourage those students to explain why they agree or disagree and eventually introduce them to another way of contributing (e.g., asking for clarification). Conversely, students who tend to see only the big picture at times need reminders to clarify their intent and statements in a way that makes sense to all students.

Integrating Curriculum / Exceeding Expectations

A common concern among educators new to inquiry is how to teach with an inquiry approach when there are so many curriculum expectations to address. By focusing on the "big ideas" rather than on the specific expectations alone, students' questions often lead to, and often exceed, overall curriculum expectations (*Natural Curiosity*, 2011). It is essential for educators to have a deep knowledge and understanding of the big ideas of the curriculum. This way, they are sensitive to the types of student cues that, if explored further, are likely to touch upon some of the overarching curriculum goals. Moreover, because ideas play such an important role throughout the inquiry process, it is only natural that opportunities exist in which students see the need to gain access to ideas and to express them in a variety of ways. In this way, inquiry-based learning gives reason to value, use and develop skills, such as reading and writing, and does so in ways that blur the conventional boundaries between discrete subject areas. Educator inquiry into practice supports this kind of integrative and creative thinking about curriculum.

Why integrate curriculum?

"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."

(Orr, 2004)

AN EXAMPLE OF INQUIRY-BASED LEARNING STUDYING THE CHARACTERISTICS OF LIVING THINGS

Intellectually stimulating learning experiences in which ideas assume a central role provide opportunities to embed curriculum expectations and to assess for learning.

- Spark students' curiosity about what living things are by reading or showing a provocative narrative about the existence of "alien life" (Burgh & Nichols, 2011). From the alien's perspective, how might it see life on earth? What exactly is meant by life? In addition to leading an oral discussion on these subjects, invite students to jot down or sketch five things that all living things (including aliens) share.
- Working in small groups, invite students to share the information they have collected so far and to identify initial patterns. Encourage them to make some claims about important components involved in living things. Even before moving on to a more sustained approach you will begin to see an integration of curriculum expectations and potential assessment opportunities.
- During the discussion, give students opportunities to make connections from their inquiry to a book or video related to living things and provide explicit instruction, as needed, in reading and listening skills and in exercising critical thinking skills.
- Having students jot down or sketch their five ideas of what it means for something to be living offers an opportunity for a baseline assessment of understanding. Later on in the inquiry, as students develop and further express their understanding of life systems, you might repeat the initial exercise and share with the students their previous work, highlighting the growth in their understanding.

Some Guiding Principles for Educators

★ DON'T WAIT FOR THE PERFECT QUESTION ...

Authentic inquiry begins with questions and problems that students want to find out more about. A common misconception is that educators must follow the students' lead and wait until the "perfect" question emerges before proper inquiry can begin. Students' spontaneous questions – when they reflect *genuine* curiosity – can be a powerful place to start. Equally, there are often times when the teacher initiates the inquiry process through a question based on a key concept in the curriculum. What is essential here is that students find these questions or problems intellectually stimulating, that they give them pause to wonder or pose a certain dilemma or offer promise in terms of sustained and systematic student engagement: "The most valuable questions are those that lead to other questions and provide germs for future investigations" (Lucas, Broderick, Lehrer, & Bohanan, 2005).

However, there are times when a student's seemingly "simple" question can lead to a full-scale inquiry. Sometimes inquiry begins not with a question or problem, but with a shared experience – a social event, a field trip, a blog, a YouTube clip, a book, etc. – that elicits student curiosity and helps establish a common starting place of wonder for all class members. Whether inquiry begins with the student, teacher or a shared classroom experience, what matters most is that the initial query sparks student interest and provides the opportunity and resources for in-depth student investigations.

★ PLACE IDEAS AT THE CENTRE ...

While all students ask questions and express interests in world phenomena, it takes creative and responsive teaching to transform wonder into knowledge. To begin, inquiry works best in a classroom in which ideas are placed at the centre (Scardamalia, 2002). Establishing a culture in which students are encouraged to express ideas but also to respectfully challenge and test one another's ideas is an important first step in the inquiry process. This spirit of inquiry is achieved by welcoming ideas and trusting that even the simplest questions can lead to something greater and not yet evident. Like any good growing system, these questions need time to germinate. Students' ideas can be expressed in many forms (questions, comments, diagrams, pictures, dance, etc.) and serve the important purpose of advancing student understanding of a topic. When the classroom culture is one that views ideas as improvable, students work hard to continuously improve the quality, coherence and utility of ideas – both individually and collectively (Scardamalia, 2002).

★ WORK TOWARD A COMMON GOAL OF UNDERSTANDING ...

No matter what the topic or direction of inquiry, it is important to bring the class together to "check in" and share and discuss the big ideas of the subject/investigation/inquiry at hand. By doing so, everyone benefits. On an individual level, students benefit by hearing perspectives different from their own, potentially revealing important insight into a particular problem or learning obstacle they may have. In Vygotskian tradition, it is through the social practice of learning and thinking that students learn to think for themselves: "Through association with others the community of inquiry will lead to a richer, more varied 'internal' dialogue, and as a result a better, more reasonable thinking, through 'self-correction'" (Burgh & Nichols, 2011). When the entire class is working toward a common goal of understanding – and different perspectives and approaches to problems are not only welcomed but also encouraged – all class members benefit by contributing to a knowledge base that is greater than the sum of individual contributions alone.

The teacher plays a critical role in moving students' ideas forward, having to decide, sometimes on a moment-to-moment basis, when and how to intervene in order to maintain and build student momentum. For example, early in the inquiry process the teacher is responsible for establishing (and modelling) classroom norms and expectations – How do we respectfully challenge an idea? What constitutes a good question? What constitutes an evidence-based explanation? It takes astute recognition on the teacher's part to know when student ideas need clarification and revoicing (e.g., through repeating, rephrasing, expanding) in order to keep the core ideas accessible to all class members (Strom, Kemeny, Lehrer, & Forman, 2001). Along these same lines, teachers mediate between the introduction and use of content-specific language (e.g., *hypothesis*) and the naturally occurring "everyday" talk of students. Through working to form common understanding, inquiry supports the co-construction of knowledge.

★ DON'T LET GO OF THE CLASS …

It is a misconception that inquiry-based pedagogy means letting go of the class and allowing students to self-direct all aspects of their learning. Students' thinking can be limited when confined to their own experiences. Educators have the privilege of introducing students to ideas that do not emerge spontaneously and from discovery alone, and similarly, they must assume the role of helping children notice things that would not otherwise be seen. Students are not only capable of sophisticated thinking – of both a concrete and abstract nature – but also express genuine interest in thinking about challenging questions and problems. Even very young children are capable of talking about such ideas as *infinity*, *space* and *natural selection*, but only if we let them and are willing to go there as learners ourselves.

★ REMAIN FAITHFUL TO THE STUDENT'S LINE OF INQUIRY …

When introducing students to new ideas and "ways of seeing," it is important to do so in a way that remains faithful to their line of inquiry; helping them overcome obstacles in their paths of learning and extending their understanding beyond what they are capable of doing alone. Impromptu mini-lessons, revisiting a former concept or idea, making certain lines of thought more explicit for children, introducing new questions and problems and redefining success criteria are all examples of "teacher moves" that allow for sustained inquiry, student engagement and improved content knowledge. One of the challenges for a teacher is deciding when and when not to intervene and this depends, to a large extent, on the teacher's best judgments of the students and their individual and collective needs as learners: "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" (Grade 5/6 teacher, as cited in *Natural Curiosity*, 2011).

★ TEACH DIRECTLY ON A NEED-TO-KNOW BASIS ….

In helping students move forward in their inquiry, it is important to recognize that not all learning opportunities call for an inquiry approach. Suppose the inquiry is focused on exploring characteristics of living organisms and microscopes are being introduced as one potential tool to gain understanding. A brief and efficient teacher-directed overview on how to use the microscope will suffice. In this way, class time is better spent and students are given more time to use the microscope en route to exploring the subject's big ideas (in this case, exploring what constitutes *life*). In an effort to help students stay focused on their line of inquiry and avoid getting sidetracked, educators must be prepared and comfortable with teaching on a need-to-know basis.

Be on the look-out for "inquiry potential" ...

Keep a record of students' questions, especially the types of questions that occur naturally and frequently among the students you teach. These questions often offer "inquiry potential" and can be held onto and introduced when the time is right. Alternatively, the questions can be posted in the classroom (on brightly coloured paper, written by the students themselves) for the community of learners to refer to throughout their investigations.

Do students play an equal partner role? Yes! And Yes!

When students are invited to take part in the learning process from start to finish, they experience a sense of agency and responsibility for their learning, an approach that lends itself to greater student engagement and intrinsic motivation (Ryan & Deci, 2000). Students are better able to evaluate and reflect on their own learning and the collective learning of the class when they have been part of the learning process from the beginning, having played an active role in the initial planning and identification of main learning goals. In fact, a key feature of inquiry-based learning is the practice of revisiting initial theories and ideas, both as individuals and as a class, and reflecting on the ways in which current understanding differs from the former. In this way, students begin to experience learning as an ongoing process, not an end point.

The core processes identified below – planning, monitoring and reflecting – are of fundamental importance in effective student learning (Watkins, 2012) and play a key role in inquiry-based classrooms.

GUIDING QUESTIONS FOR STUDENTS IN AN INQUIRY CYCLE

Planning the Course

What have we observed so far? What are some of our initial understandings of the phenomenon being studied?

What are some of our initial theories? What can we do to test our initial theories?

What are the questions that our whole group needs to work on to develop further understanding?

What is the problem or question and how can it be approached? Are some approaches better than others?

What is our current understanding and how can it inform how we go about our learning?

What are the first steps in going forward?

Monitoring Progress

How are we progressing? Are we making good headway in working toward our learning goal(s)?

What kind of discussions or presentations or group experiences are useful in sharing our learning / moving our learning forward?

How are other students working toward the same problem/question? How can we use what we've learned from others to inform our own inquiry? How might we use what we've learned to help others in their learning?

Reflecting on Lessons Learned to Consolidate Inquiry

Did we achieve our learning goal(s)? How do we know? What do we know now that we didn't know at the beginning? What route did we take to get here? Would we take the same route again?

What obstacles did we face along the way? How were these obstacles dealt with? Did different people approach these problems with different solutions?

How has the process led to new understanding? How has the process led to new questions?

How does our learning change the way we think about other things in the world?

Ways to Build Student Contributions

Along with the belief that students are capable of taking responsibility for their own learning is the belief that all students are capable of contributing to the collective improvement of ideas and understanding. To create a culture of this sort, students need to be made aware of the different kinds of contributions that can be brought to the group. For example, proposing theories, building on a theory or idea, choosing to agree or disagree with a statement, synthesizing individual ideas and class-wide themes and making connections to related experiences in the wider world are all examples of the various kinds of student contributions that can be made.

Early in the year the teacher can model different types of contributions for the students and demonstrate how these different types of responses play out. Over time, the goal is to have a classroom of students who are able to carry on a group discussion (ideally student led or with little assistance from the teacher) in a way that demonstrates flexibility and recognition in knowing when and how to contribute in order to move the entire group's learning forward.

It is important to honour the diversity of contributions and make it clear to the class that all contributions are not only welcomed but also necessary in helping everyone's learning (e.g., *"I really liked the way you asked for clarification, Prateem ... that helps all of us understand what Sophia meant a little better."*). The teacher plays an important role in modelling for students the different ways of contributing to the group discussion. The table below provides examples of the different ways students might contribute in a collaborative inquiry setting.

Keep focused on the big ideas ...

Use your professional knowledge and judgment to recognize when students are caught up on an idea or line of inquiry that offers limited access to the big ideas. Through asking students to question their method of inquiry (and its future direction) and by introducing students to new ideas or information, educators play a key role in keeping the inquiry focused and robust.

Types of student contributions	Examples of student responses	Examples of prompts used by students and teachers to extend the contribution
Declarative statements	"I agree with what _____ said," or alternatively, "I disagree with what _____ said." "The answer is 16."	"Can you give a reason for why you agree (or disagree) with what _____ said?" "What's your evidence?" "How do you know the answer is 16? Can you share with us how you got that answer?"
Building on	"Building on to what _____ said, I think it's also important that…"	
Paraphrasing/clarifying/ synthesizing	"So far, this is what I understand we've been discussing…" "When you were talking about how the triangle and square took up the same area, did you mean that they share the same area because...?"	"That's a very good summary of the big ideas we've been discussing. Does anyone else have anything to add?"
Making connections	"What you said reminds me of what we learned about how ecosystems work…they both depend on a whole bunch of other things to work properly." "Oh, 2 x 3 and 3 x 2 gives you the same answer in the same way that 2 + 3 and 3 + 2 are the same answer… It doesn't matter what order you do the adding or the multiplying in."	"That's an interesting connection. What other ways might these two things be related? Do you think that will hold true for *all* addition or multiplication number sentences? Why or why not?
Asking questions	"I wonder what would happen if you took out the plants in the aquarium. Would the fish get sick?"	"What do people think? It might help to first think about what sorts of functions plants carry out? Why are plants in the aquarium important?"
Proposing theories	"Fish need oxygen to live, just like us, so I think that removing the plants will harm the fish by making it harder for them to breathe."	"How could we test this theory without actually harming the fish?"

INQUIRY-BASED LEARNING IN BRIEF
FROM SPARKING CURIOSITY TO SUSTAINED INQUIRY

Getting it started ...

- Make ideas the "central currency" of the classroom – the work of everyday teaching and learning.
- Model classroom norms of respectful discussion.
- Intervene to build momentum and to make sure all students understand and are invested in the ideas being discussed.
- Build on spontaneous questions that cause students to wonder and to ask further questions.
- Connect student questions and ideas to the big ideas of the curriculum.
- Keep student thinking at the centre by involving students in initial planning of the inquiry.

Keeping it going…

- Engage students in knowledge-building by bringing them together frequently to share thinking and discuss the big ideas of an inquiry.
- Teach "on-the-spot" direct instruction mini-lessons when you see that students need to know certain pieces of information and have certain skills to move forward.
- Balance content-specific language with everyday student talk.
- Continually assess what's happening in the inquiry to make judgments about when and when not to intervene.
- Revisit initial theories and ideas about a question and reflect on the ways that the initial understanding differs from current understanding.

Reflecting on learning ...

- Explicitly teach students what metacognition or reflective thinking is – talk about how learning deepens when we plan for it, analyze it and monitor our progress.
- Make sure students have time every day to practise metacogitive habits, such as reflecting on how they are progressing, how they are dealing with problems and how they are coming to new understandings.
- Use the guiding questions from Reflecting on Lessons Learned on page 6 to frame discussion about an inquiry – have students put the questions into their everyday language to make them their own.

REFERENCES

Burgh, G., & Nichols, K. (2012). The parallels between philosophical inquiry and scientific inquiry: Implications for science education. *Educational Philosophy and Theory, 44*(10), 1045–1059.

Fielding, M. (2012). Beyond student voice: Patterns of partnership and the demands of deep democracy. *Revista de Educación, 359*, 45–65.

Kuklthau, C.C., Maniotes, L.K., & Caspari, A.K. (2007). *Guided inquiry: Learning in the 21st century*. Westport, CT & London: Libraries Unlimited.

Lucas, D., Broderick, N., Lehrer, R., & Bohanan, R. (2005). Making the grounds of scientific inquiry visible in the classroom. *Science Scope, 29*(3), 39–42.

Natural Curiosity: Building children's understanding of the world through environmental inquiry/A resource for teachers. (2011). Toronto: The Laboratory School at the Dr. Erick Jackman Institute of Child Study.

Orr, D. (2004). *Earth in mind: On education, environment, and the human prospect*. Washington, D.C.: Island Press.

Pauli, G. (2009). How can we use finite resources to propel ourselves in the future? TEDxTokyo, Retrieved March 12, 2013, from http://www.tedxtokyo.org/en/event/tedxtokyo-2009/

Quigley, C. Marshall, J.C., Deaton, C.C.M., Cook, M.P., & Padilla, M. (2011). Challenges to inquiry teaching and suggestions for how to meet them. *Science Educator, 20*(1), 55–61.

Ryan, R.M., & Deci, E.L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology, 25*, 54–67.

Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Ed.), *Liberal education in a knowledge society* (pp. 67–98). Chicago, IL: Open Court.

Strom, D., Kemeny, V., Lehrer, R., & Forman, E. (2001). Visualizing the emergent structure of children's mathematical argument. *Cognitive Science, 25*, 733–773.

University of Toronto, Ontario Institute for Studies in Education (OISE). Robertson program for inquiry-based teaching in math and science. Retrieved March 12, 2013, from http://www.oise.utoronto.ca/robertson/index.html.

Watkins, C. (2012). Learners in the driving seat. *Leading Learning Pedagogy, 1*(2), 28–31. Retrieved February 18, 2013, from www.teachingtimes.com