

Inquiry Based Learning in Mathematics

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What is Inquiry-based learning?

Excerpt from Ontario Capacity Series, page 2, May 2013.



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.

Types of Inquiry

The following summary on the types of inquiry was written by Michelle Hikida, a Richmond Teacher.

Structured Inquiry

- The teacher determines the big idea and what the students will come to understand by the end.
- The teacher starts with a guiding question.
- The students will help create the plan and guide the inquiry with their questions, interests, ideas, analysis, reflections, and understandings.

Guided Inquiry

- The teacher comes up with the big idea or topic and students and/or the teachers come up with the questions.
- The students are responsible for designing and following their own procedures to test the question and then communicate their results and findings.

Open Inquiry

- The students determine the purpose and formulate the questions.
- The students design the procedures, gather the materials and communicate their findings.
- The teacher facilitates, supports, asks questions and redirects the investigation.

PLAY – Principles defined by Stuart Brown

Diminished consciousness of self

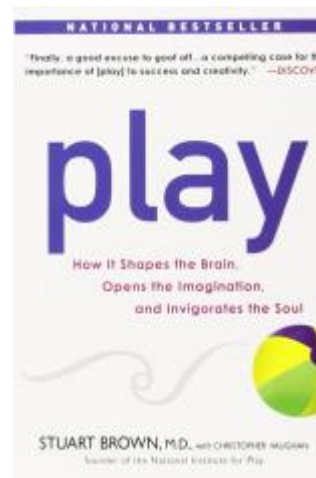
- no good or bad
- willingness to take risks

Improvisational Potential

- through its' openness it invites
- co-constructing understanding

Continuation Desire

- it hooks! Focused attention
- self motivated



The Structure of the lesson

A Lesson Format for a whole class Inquiry-based learning

1. Engage your students with – Activate prior knowledge –
Clear learning intentions

2. Pose the Problem
 - Allow the children an opportunity to ask questions, seek clarifications and share possible strategies.

3. Exploration/Conferencing/Assessing
 - Children are given an opportunity to engage with the open-ended problem or provocation independently, with a partner or in a small group.
 - Children are able to access whatever manipulatives they need to solve the problem (unifix blocks, egg cartons, rulers, 100's charts, calculators, base ten blocks, ten frame cards). All the manipulatives are kept in places that the students can access easily and independently.
 - While the children are working, the teacher circulates around the room and conferences with the children. This provides the teacher with an opportunity to listen and assess where the children are at, as well provide the student with descriptive feedback and ask effective questions to nudge the learning forward. The information gathered from these informal conferences is used to guide future lessons. In other words, this is the formative assessment piece. What's working? What's not? What's the next activity/problem that should follow that would meet the current needs of the class and assist them in reaching the big math ideas/curriculum goals?

4. Sharing
 - Children are given an opportunity to share their questions, challenges, connections, strategies and successes.
 - By sharing their thinking with others, it allows the children to reflect and understand what they have done, as well as see other possible ways to solve a problem, building their repertoire of strategies. By seeing other methods, children come to realize that there is no one "right" way to solve a problem, but rather many different approaches or even answers to a given problem.
 - By listening and seeing other strategies, children can make connections between the strategies and ideas.
 - This sharing time also provides the teacher with another opportunity

to assess the students for future learning.

- As the facilitator of learning, I also often choose to highlight different concepts or connections I saw students making. When circulating I make note of whom I would like to share and I often snap a photo of the student's work so that we can share this with the class. Photos are a great way to capture students' work. During the sharing period it is important to ask questions to elicit and nudge learning forward. (e.g., How is this similar to _____? How is this different from _____? How is this related to _____?)

Formative Assessment is on-going

While the students are working, circulate and ask questions that will facilitate your knowledge of their mathematical thinking and understanding. Tracy Zager's book called *Becoming the Math Teacher You Wish You'd Had* has some great prompts/questions to use when circulating.

- What's going on here?
- What are you noticing?
- What do you wonder?
- Tell me something about this problem.
- Forgot about the question for a second. What's going on in this situation?
- What do you estimate the answer might be?
- How did you decide what to do next?
- Do you have a plan, or were you just trying things out?
- Where did you get the idea to do it that way?
- How did thinking about your experience with _____ help you here?
- Keep going...
- What else?
- Keep talking. I think you are onto something here.
- Say more about that.
- This is what I think I heard you say. Do I have it right?
- What might be another way of thinking about this?
- Who has another strategy?
- Turn and talk with a partner about your thinking.
- I'm not sure everybody knows this. Would you be willing to share your thinking when we gather back together as a class?

Once finished you could record the student's responses on either speech or thought bubbles and create a bulletin board that puts their thinking on display. Another great resource with suggestions on questions teachers can ask, is the Ontario Capacity Series article called "Asking Effective Questions". Here is the link

http://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/CBS_AskingEffectiveQuestions.pdf

Key Resources:

- Ontario Capacity Series – Inquiry Based Learning:
http://www.edu.gov.on.ca/eng/literacynumeracy/inspire/research/CBS_InquiryBased.pdf
- Natural Curiosity - <http://www.naturalcuriosity.ca/>
- Galileo Network - <http://galileo.org/>
- Janice Novakowski's websites -
<http://blogs.sd38.bc.ca/sd38mathandscience/>
http://janicenovkam.typepad.com/reggioinspired_mathematic/

The Open Questions for the Number Strand are available via LRS. The Patterning books are NOT available yet, but will be in the Spring, when a WNCPS correlated version will be published. Currently the Patterning and Measurement book is only correlated for Ontario. Should you wish to order them now you can order from Ben Minuk 604-278-9891 as he is a rep for Rubicon Publishing.

#173627 \$49.95 K – 3 Number Strand

#173628 \$49.95 4 – 6 Number Strand



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