Developing more curious Minds -- John Barell

Introduction	The ability to pose good questions when confronted with complex situations contributes to our growing up to living our lives to the fullest potential. The whole art of teaching is only the art of awaking the natural curiosity of young minds for the purpose of satisfying it afterwards … Anatole Frances (1932, p238)
What's the problem	In real life our culture is too not ask hard questions: • 9/11, challenger disaster, Iraq invasion • Enron disaster • People feel threaten, might under cut the value of parental values & religion Preserving the Status Quo … students not being challenged on building huge bonfire at university Prefer that others make the decision … act like cattle.
Curiosity	Curiosity stimulates intellectual development Brain growth is the results of interacting with enriched environments … Marion Diamond These enriched environments are characterized by: • Novel challenges • Opportunities for fee choice & self-direction. • Stimulation of all the senses. • Pressure-free social interaction • Experiences of self-assessment Our minds thrive upon the driving process of inquiry – our striving to find and figure out what seems strange, unusual or novel.
Examples ***Skepticism is a virtue***	Leonardo da Vinci … Wandering around the hills of Tuscany, not too far from Florence, Leonardo made an amazing discovery; fossilized seashells. Friend said the must have blown up there or another answer was they were driven upwards by the violent currents of Noah's flood. He did not buy these explanations because what he observed were many whole shells, not broken ones that would come from other explanations. He never did figure out what the true story was. _____ Some people think that, in times of crisis, to question is unpatriotic. The point of view is that dissent can "give ammunition to America's enemies and pause to America's friends" Ashcroft, 2001 _____ Isidore I. Rabi .. (Nobel Prize in Physics in 1944) mother would ask him each day when he returned from school **"did you ask a good questions today"** that made me become a scientist.
Models of inquiry	Fostering inquiry and skillful thinking is one of our most important

curricular goals.
Wonder and skepticism—their harmonious marriage ought to be a principle goal of public education .. (Sagan, 1996 p 306)

Wonder, inquiry, skepticism and doubt--- the pillars of our civilization, the promise of our future on the planet.

Content	Dispositions/Attitude	Skillful thinking
Of major concepts/ ideas Within our subjects: ”we know that-“	Wonder/curiosity:’ What if?” Healthy skepticism/doubt openness to mystery/ambiguity Empathy Collaborating with others Risk taking	Problem solving Critical thinking Hypothesizing/creating Ways of knowing

Open-Ending Inquiry:
One teacher to get to a “Learning Community” starts off her class with tow questions:

1. What questions do you have about yourself
2. What questions do you have about the world

These two questions lead students to reflect on those experiences that have raised important questions in their lives. The students are then encouraged to organize them into categories, to search our similar themes and issues. Then they make priorities with the broad classification of questions.
as an example, a question “Will I live to be 100 years old” spawned educational investigations into genetics, family and oral history, actuarial science, statistics and probability, heart disease, cancer and hypertension.

We are all curious folks, wondering and speculating, searching for answers to questions we find fascinating, amazing and perplexing.

Creating schools of inquiry

How do they know?

Setting a classroom culture:
We need to communicate our valuing curiosity through:

- Setting high expectations
- Using teacher modeling
- Sharing our stories
- Developing positive scripts
- Creating questions and responses
- Offering assignments and assessments
- Raising the quality of peer interaction
- Encourages risk taking and mistakes

- Respecting our follow class-mates thoughts

Climate of conducive to learning;
We communicate to students the expectation that curiosity and wonder are valued elements in this classroom.
No rules except high expectations
Model questions over and over:

- What are you curious about?
  What do you want to know more about?
- What isn't clear?
- What do you wonder about?

If we wish to foster curiosity, wonder and skepticism, the following questions we can ask ourselves aloud, in front of our students often enough that they can become mental habits for ourselves and our students:

- What I am curious about is….
- What I do not yet understand is…
- I really want to find out..
- The mysteries and puzzles that really intrigue me are..
- If I could be somebody else … or visit another time period, that is what I'd want to discover …
- I really wonder why…
- What intrigues me is…

Model Questions: … we should be asking our students
Now, what questions do we need to ask of this situation.
Whenever we encounter complex situations in our subjects, we pose certain crucial questions:

- What do we know?
- What are the givens?
- What do we need to find out?

In math, students migh also dig deeper and reveal their knowledge of problem solving by asking:

- How does this problem relate to other I've solved already?
- Can I break this problem into parts?
- How can I represent this problem/

these are excellent problem solving script questions that can be embed within our normal approach in all subjects.

- **Teachers response:** very important that the teacher appear to be listening to the student and use some of the following response:

  - Please tell us more. We're interested in your thoughts
  - Can you explain or expand on your thinking

	• How can you relate this to what ----- has said/ • Can you relate this to other concepts/ideas we have been studying? • How did/ does this make you feel/ • How do you know? What led you to that conclusion? • Can you tell us how you figured that out?
Peer Interaction	A powerful way to foster inquisitiveness among our students is to teach them to response actively to the comments of their classmates. • When responding to a comment or a question, I will peak to the whole class, not just the teacher • When I hear something form one of my classmates that I doubt, or am curious about, I will ask her or him a question. It can generate high-quality problem solving and decision making and therefore, deeper understanding of complex issues.
What makes a question good? ***What side of this argument are you on and why?***	• A good question makes you think. • A good question is one that does not have an immediate answer, because it requires some thinking, feeling and application to previous knowledge. • A good question opens doors. It demands more than a yes or no answer. **Blooms** list became a rigid set of intentions for teachers to use in the classroom. Knowledge (Recall, Description …) • Comprehension (Understanding content …) • Application (Using knowledge in novel contexts …) • Analysis (Breaking complex issues into parts …) • Synthesis (Combining elements into novel designs …) • Evaluation (Using criteria to make judgments …) Levels of difficulties as we move from knowledge and comprehension to synthesis and evaluation. Another framework is known as the Three-Story intellect. 1. Gathering 2. Processing … understanding 3. Applying We can teach our students each of the Frameworks so they can identify the kinds of questions they are posing. One of the best ways to acquire and retain knowledge is by solving a problem. Thinking in this manner to create the questions is a good way to start. We should be asking ourselves three powerful questions as we work and go about our daily lives;

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Planning; What's the problem and how will I go about solving it?
Monitoring: How well am I doing in working toward my goal?
Evaluating: How well did I do? What would I do differently next time? Why?

Similar metacognitive process questions include:
How did you figure that out?
What made you think of that question/answer/
Can you describe your thinking processes as you worked through this problem?
</td></tr>
<tr><td>Topic related questions</td><td>
Social Justice:
What do you think about this situation?
What questions does it raise in your mind?
What actions might we take?
The big idea in your subject area:

What would be the 3 major questions regarding teaching the course on using the engineering design process as a driver to improve math and science learning?
How would I question the disclosure of a new engineering tool or process?

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<tr><td>Engineering journal</td><td>
A thinking journal is a place where a person can be alone with his or her thoughts, reflecting on what has occurred, making observations, attempting to figure out what happened and why, and generating some questions for the future.

Field notes are for the purpose of recording one's impressions during an expedition and analyzing them later on.
Structuring our notes:

Questions to research
Plan of investigation
Technology we will use in the field
Kinds of evidence we will search for and gather information about.
Alternative conclusions ruled out because…
Conclusions and explanations

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<tr><td>What if questions, though questions</td><td>Albert Einstein's questions on riding on a light bean, what would I see?
What kind of "what if" question might you ask students about a topic or concept or experience now that would test the limits of their understanding?</td></tr>
<tr><td>Problem Solving</td><td>What is my problem?
How will I go about solving it? (Identify strategies, not solutions)
How well am I doing?
How well did I do (after reaching a solution)? Would I do anything differently, and why or why not?</td></tr>
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Thinking Process	Reading and rereading for understanding Breaking the problem into smaller steps Relating it to ones done in the past Checking and monitoring progress, following be self-correcting.
Motivation in the Classroom **	Children locked into classroom discussion are no different than adults locked into boring, irrelevant meetings. If you do not understand how something relates to your goals, you will not care about that thing. If an adult cannot see the relevance of the material covered in a meeting, and has no desire to score political points, he will tune out or drop out. If a child does not understand how knowing the elements of the periodic table will help to address the concerns of his life, and he is not particularly interested in pleasing the teacher, he will do the same. Because we do not want our children to be motivated solely by a desire to please the teacher, what we need to address is how to make the content of the curriculum fit into the concerns of the child. Sometimes, this is easy. The child who wants to design a roof for the family doghouse will gladly sit through a lesson on the Pythagorean theorem if he understands that the lesson will teach him how to calculate the dimensions of the roof he needs. If a piece of content addresses a particular concern of a student, or even a general area of interest, that student will not tune it out. Most children, as they work through their years of school do, in fact, find areas of study they genuinely enjoy. But these areas are different for different people. The general problem of matching individual interests to fixed curricula is one that is impossible to solve. People obviously have different backgrounds, beliefs, and goals. What is relevant for one will not be relevant to another. Of course, we can force something to be relevant to students--we can put it on the test. But this only makes it have the appearance of significance, it does not make it interesting. Some children decide not to play the game this system offers. Instead, they continue to search for ways in which what is taught makes sense in their day-to-day lives, becoming frustrated as they realize that much of what is covered is irrelevant to them. If children are unwilling to believe that their own questions do not matter, then they can easily conclude that it is the material covered in class that does not matter. What is left, then, if the content has no intrinsic value to a student? Any teacher knows the answer to this question. Tests. Grades. When students don't care about what they are learning, tests and grades force them to learn what they don't care about knowing. Of course, students can win this game in the long run by instantly forgetting the material they crammed into their heads the night before the test. Unfortunately, this happens nearly every time. What is the point of a system that teaches students to temporarily memorize facts? The only facts that stay are the ones we were forced to memorize again and again, and those we were not forced to memorize at all but that we learned because we truly needed to know them, because we were motivated to know them. Motivation can be induced artificially, but its effects then are

	temporary. There is no substitute for the real thing.
Children as teachers **	Sometimes students can be their own best teacher if they just have someone around to listen to the ideas they are coming up with. Of course, schools tend to allow very little time for such student reflection and even less time for teachers to just listen. Students rarely try out their thoughts on teachers because they know there is no possibility that the teacher would have the required time, the patience, and ability to reserve judgment. But when students are allowed to devise and pursue activities in which they are interested, they naturally generate ideas, hypotheses, and questions. They are ready to learn from their own ideas if we can find a way to help.
Insightful questions **	Insightful questions indicate that a student has an idea or a problem on which he is working, and wants to learn more about it. The student wants to explore and broaden his ideas. Exactly what is it that such a student wants to learn? Facts are not usually what he wants to learn. More typically, he wants to learn about implications and alternatives, suggestions about his planned approach, different ways of looking at a problem, and so on. He wants someone to help him think through his ideas or problems on his own. When these problems are personal, some people go to psychiatrists. But where do we go if the problems are technical or managerial, or everyday (but hopefully non-neurotic) in nature? Well, then we go to a friend, a colleague, or occasionally, a teacher who is a good listener. When students come to teachers with half-formed ideas they want to flesh out, the role of a good teacher is to ask questions, not tell answers. The role of the teacher during the questioning process is to help the student see the shortcomings in his thinking. It is to open his eyes to alternatives, erroneous assumptions, and eventualities he has not considered. It is, most of all, to challenge the student to develop a deeper understanding of his own knowledge. In order for the student to gain such an understanding, he must experience expectation failure. A teacher should aim to provide the questions that will lead the student into the understanding cycle. Asking questions at the right time is a critical role of a good teacher. This statement summarizes what we call the sounding board model of teaching. When teachers adopt the role of sounding boards, they should allow students to speculate, wonder, imagine, and be creative. However, it is rather difficult for teachers to be effective sounding boards. Teachers like to tell the correct answers to students. Teachers do not have the time to sit with students, and encourage them to pursue the implications of what they are thinking. Additionally, teachers often fall into the trap of thinking they are asking questions when they are really only delivering answers using the syntactic guise of a question.
Learning	The notion of coverage, of going through a bunch of disciplines, and

approach John Gardner**	learning facts and concepts, is assessed by schools all over the world. It's never been a very good idea, but now it's really irrelevant. I would throw away 95 percent of the coverage that we do; figure out really important questions and issues, and give people lots and lots of time to learn about how disciplined minds think about those issues, and then to practice those disciplines themselves.
Inquisitiveness How do you know? What makes you think that? I don't get it How'd you get that? Why is it like that?	What Inquisitiveness looks like: • students persists in examination and observations • Seeks out a wide variety of resources for projects • Is open to a wide variety of interpretations or points of view and ambiguities • Has respect for factual information, attempts to clarify issues • Evidences a healthy skepticism about claims, judgments, and generalizations, searches for underlying assumptions. • Thinks of multiple ways to solve problems or approach issues • Pokes, prods, and examines objects and phenomena at length

Were we good thinkers today? Assessment strategies for the students

Cues for Effective Questioning

Ways to Engage, Enhance, and Extend Student Thinking

- Ask open-ended questions
  Reword questions to eliminate yes/no responses.
- Develop questions carefully
  A few, "higher-order" questions are more productive than a lot of "lower-order" questions.
- Use precise language
  This enables students to associate specific language with thinking processes and cues student responses.
- Practice "wait-time"
  Provide 3-5 seconds of silence after a question and after a response.
- Call on students randomly
- Acknowledge all responses
  Passive (i.e., a nod) and active (i.e., paraphrasing) acceptance demonstrates that a response is valued.
- Withhold criticism
  Respond to student answers non-judgmentally.
- Paraphrase more often than praise
  This communicates that you've heard and that you understand. Doesn't encourage conformity.
- Use praise sparingly
  When used, give criteria.
- Rephrase rather than repeat
  When students don't understand, rephrase own question. Ask students to rephrase response when clarification is needed.
- Ask students to "think about thinking"
  Provide opportunities for reflection and for "thinking aloud".
- **Plan for productive interaction**

"Think-pair-share" and small group cooperative learning encourage thoughtful student-student interaction.

- Encourage question-asking
  Provide opportunities for students to develop own questions.
- Thinking skills improve with practice
  Remember, thinking processes are developmental, so hang in there!

Questioning for a Range of Thinking

Examples of Questioning for Specific Types of Thinking

- Knowledge: remembering, reciting, recognizing
  Who/what/when/where is _____?
  What do you remember about _____?

- Comprehension: understanding, translating, estimating
  Given _____, what would you predict?
  What is meant by _____?

- Creative thinking: elaborating, taking another point of view, brainstorming
  In what other ways can you _____?
  What details can you add to _____?

- Application: using, demonstrating, solving
  How can you solve this (similar situation)?
  How could you use _____?

- Analysis: comparing and contrasting, inferring, attribute listing
  How is this _____ like/different from this _____?
  What are the characteristics of _____?

- Synthesis: hypothesizing, planning, creating
  How would you create a _____?
  What plan can you develop for solving _____?

- Evaluation: justifying, rating, judging using criteria
  What criteria would you use to _____?
  Why do you agree/disagree with _____?

Adapted from Benjamin Bloom and Donald Treffinger

Examples of "Generic" Questioning

- Questions calling for variety
  What are some different ways you could _____?
  What else might happen if _____?

- Questions calling for clarification or extension
  What do you mean when _____?

How is your description different from _____?

- Questions calling for reasons or support
  Why do you think that is true for all _____?
  What makes you think so?

- Questions asking students to focus on the task at hand
  What do you think might happen as a result of this (already discussed aspect)?
  What would you do in this _____?

Adapted from Hilda Taba

Questioning Within, Among, and Beyond Strategies and Lesson Types
Examples of Questioning to Build, Bridge, and Transfer

Following early skill development in the "problem solving thinking phases", questions can be posed to help students…
build skill within a specific thinking phase(s), strategy or Lesson Type so that the purpose, characteristics, and applications are fully understood.

  - How can you decide what information should be included in the headings when making a table?
  - How did looking back at this problem assist you in discovering alternative solutions?
  - Why was it helpful to solve this problem in a small group?

- bridge or identify the connections among the attributes of problems, two or more strategies, and Lesson Types.
  - How is the organized list strategy different from the make-a-table strategy?
  - What is it about this problem that reminds you of yesterday's problem? What do these characteristics tell us about strategies we might use with today's problem?
  - How did your group improve upon the social skill that was introduced yesterday?

- **transfer** their learning about one or more thinking processes, problems, or strategies to other academic or real-life situations.
  - In what real-life situations would drawing a picture be helpful?
  - What can we learn from our desire to jump into solving a problem that will help us in other subject areas?

Questions that build, bridge, or transfer may be appropriate in any of the "problem solving thinking phases" as well as in whole group "debriefing".

This material excerpted with permission from "Cues for Effective Questioning", by Cathy J. Cook and Claudette M. Rasmussen, June, 1989, NCREL. For a copy of the full text, which includes "Questioning to Develop Mathematical Power" and "Questioning for Critical Thinking in Mathematical Problem Solving," contact Cathy Cook at 630.571.4700

Guiding Questions for Engaged Learning Design

(Adapted from Learning with Technology, NCREL)

Engaged Learning Action	**Guiding Questions**	**Unit of Practice Evidence**
Learning Tasks: • The tasks are authentic • The tasks are challenging • The tasks are multidisciplinary	• In what ways are learning tasks connected to the real world and relevant to students? • In what ways are learning tasks complex enough to require students' effort and time? • In what ways do learning tasks draw on several disciplines?	
1. Build Knowledge and Skills: o Student as explorer o Student as cognitive apprentice	1. In what ways do learning tasks help students discover concepts through interacting with the world? 2. In what ways do learning tasks encourage students to construct knowledge in deep and meaningful ways? 3. In what ways do learning tasks enable students to observe and apply practitioners' thinking skills?	
Engaged Learning Action	Guiding Questions	**Unit of Practice Evidence**
1. Learn Independently and With Others: 2. Teacher as facilitator 3. Teacher as guide 4. Teacher as co-learner and co-investigator 5. Student as teacher	1. In what ways do learning tasks demonstrate the value of diversity and multiple perspectives? 2. In what ways do learning tasks support the role of the teacher as a guide to students who are solving problems, engaging in authentic tasks, and sharing knowledge? 3. In what ways do learning tasks support the teacher as co-learning and co-investigator? 4. In what ways do learning tasks help students teach each other?	
1. Demonstrate Knowledge, Ability, and Creativity Performance-based assessment Seamless, ongoing assessment Student as producer	1. In what ways do learning tasks encourage students to create assessment criteria and tools? 2. In what ways do learning tasks require students to develop presentations and other performances that demonstrate what they know and can do? 3. In what ways do learning tasks enable students to create useful products for	

	themselves or others?	
1. Manage Learning Student as self-director and manager Performance-based assessment Generative assessment	In what ways do the tasks encourage students to be responsible for their own learning? In what ways do the tasks enable students to make decisions about their learning?	