Learning through Inquiry
What, Why, How

Inquiry learning is an intriguing and exciting way to teach. It involves students as active learners, learning real life skills. Traditional student and teacher roles are changed from a "sage on the stage" approach to a collaborative relationship. Inquiry learning is very adaptable and can be used to different extents depending on desired learning outcomes.

Inquiry learning is based on wonder and the questions that naturally emerge when engaged in active learning. In an elementary math class, inquiry learning might look quite different than in a science high school activity. It can be used in all disciplines and has been proven to be an effective teaching strategy through numerous research projects.

Following is a summary of some of the aspects of inquiry learning from a number of different sources. This is meant to be a general guide without getting into all the details of different inquiry applications. Start where you are comfortable (maybe just by adding some inquiry questions to a unit) and enjoy watching your students become engaged, self-driven learners.

WHAT is Inquiry Learning?

Definition: Inquiry based approaches to education focus on student constructed learning as opposed to teacher-transmitted information.

"Tell me and I forget, show me and I remember, involve me and I understand." The last part of this well-known quote is the essence of inquiry-based learning. Inquiry implies involvement that leads to understanding. Furthermore, involvement in learning implies possessing skills and attitudes that permit you to seek resolutions to questions and issues while you construct new knowledge.

Individuals carry on the process of inquiry from the time they are born until they die. This is true even though they might not reflect upon the process. Infants begin to make sense of the world by inquiring. From birth, babies observe faces that come near, they grasp objects, they put things in their mouths, and they turn toward voices. The process of inquiring begins with gathering information and data through applying the human senses: seeing, hearing, touching, tasting, and smelling.

In general, the traditional approach to learning is focused on mastery of content, with less emphasis on the development of skills and the nurturing of inquiring attitudes. The current system of education is teacher centered, with the teacher focused on giving out information about "what is known." Students are the receivers of information, and the teacher is the dispenser. Traditional classrooms tend to be closed systems where information is filtered through layers to students. Lesson plans are used to organize the various steps in the learning process for the whole-class approach. Questioning is frequently fact based rather than open ended.

The inquiry approach is more focused on using and learning content as a means to develop information-processing and problem-solving skills. The system is more student centered, with the teacher as a facilitator of learning. There is more emphasis on "how we come to know" and less on "what we know." Students are more involved in the construction of knowledge through active involvement. The more interested and engaged students are by a subject or project, the easier it will be for them to construct in-depth knowledge of it. Learning becomes almost

effortless when something fascinates students and reflects their interests and goals (Concept to Classroom).

A Context for Inquiry

Unfortunately, our traditional educational system has worked in a way that discourages the natural process of inquiry. Students become less prone to ask questions as they move through the grade levels. In traditional schools, students learn not to ask too many questions, but to listen and repeat the expected answers.

Some of the discouragement of our natural inquiry process may come from a lack of understanding about the deeper nature of inquiry-based learning. There is a tendency to view it as "fluff" learning. Effective inquiry is more than just asking questions. A complex process is involved when individuals attempt to convert information and data into useful knowledge. Useful application of inquiry learning involves several factors: a context for questions, a framework for questions, a focus for questions, and different levels of questions. Well-designed inquiry learning produces knowledge formation that can be widely applied.

Inquiry classrooms are open systems where students are encouraged to search and make use of resources beyond the classroom and the school. Inquiry learning is process rather than content-driven learning. Teachers who use inquiry replace lesson plans with facilitated learning plans that account for slight deviations while still keeping an important learning outcome in focus. They meet on-target questions with, "How do you suggest we investigate that question?" Inquiry learning is not unstructured learning! Inquiry lessons can vary from student directed (usually still within a specified topic) to a more teacher-directed process. Teachers determine the overall topic and the learning objectives for the activity. Teachers may come up with a broad essential question to focus student investigation or they may identify specific criteria for data collection or analysis.

Perhaps a good way to summarize the important difference between traditional learning and inquiry learning is: Traditional learning focuses more on LEARNING ABOUT THINGS, while inquiry learning focuses more on LEARNING THINGS! Another useful way to contrast the two might be: Thinking WHAT as opposed to thinking HOW (Concept to Classroom).

Inquiry learning is not new. Socrates taught by asking questions and allowing and facilitating the ensuing discussions. There are many different ways to name and/or use inquiry in education. Inquiry involves constructivism and is often project based. Problem based, future problem solving, Guided and Open Inquiry, and Scientific Inquiry relate to the same methodology.

WHY use Inquiry learning?

Inquiry-based curriculum has been shown to develop independent and critical thinking skills, positive attitudes and curiosity toward science and increased achievement in biological content. Studies have shown that university students who completed a semester-long introductory biology laboratory designed on inquiry-based approaches achieved 6% higher grades on biology content exams as opposed to the control group which completed a more traditional information-transmission modeled laboratory ("What is Scientific Inquiry?" Wetzel).

Importance of Inquiry

Memorizing facts and information is not the most important skill in today's world. Facts change, and information is readily available. What's needed is an understanding of how to get and make sense of the mass of data. Educators must understand that schools need to go beyond data and

information accumulation and move toward the generation of useful and applicable knowledge. Inquiry is not so much seeking the right answer—because often there is none—but rather seeking appropriate resolutions to questions and issues (Concept to Classroom). Inquiry strategies enhance learning based on increased student involvement in the process. Students choose learning based on a topic (usually within a set range) that is of interest to them. This leads to active construction of meaningful knowledge rather than passive learning of facts. Inquiry learning allows students to make some choices based on learning styles and multiple intelligences.

Student Benefits

- Learning of collaboration skills (21st century skill) between students and between students and teachers
- Having the opportunity to use multiple learning styles and intelligences
- Using a constructivism approach in which students are active participants in the learning process rather than passive recipients of information
- Becoming problem solvers rather than direction followers
- Learning becomes process rather than product oriented
- Connecting with real world problems and situations
- Applying skills of different disciplines (math, language arts, social studies)
- Proposing questions, explanations, and predictions
- Using tools to gather, analyze, and interpret data
- Gaining useful knowledge about the natural and human-designed worlds

HOW do you use Inquiry in teaching?

Almost any topic can become the foundation for an inquiry-based project by modifying an existing lesson plan to an inquiry approach. Suppose you've decided on invasive species as a topic. Ask the kids what they would like to know about invasive species, and generate questions based on student interest (see "Quescussions" below.) Have students help prioritize the questions to limit the scope of the inquiry. For integration, consider the questions identified and map the questions to other areas of study.

The inquiry process involves these basic steps:

1. **Explore and Make an Observation**
   I am curious about…
   It surprised me that…
   I wonder how this part affects another part of the system …
2. **Question**
   Meaningful questions are inspired by genuine curiosity.
   Questions I could investigate are…
3. **Investigate**
   Follow the curious impulse and start the investigation process. Develop a plan to collect information that will help answer your question.
   What information is needed? (sight, sound, feel smell)
   How will information be collected? (record sheet, drawings, photos, video)
   How will information be organized to answer your question?
4. **Answer**
   What does the information tell you?
   Can you answer your question with this information?

What conclusions can you make?

5. **Reflect**
   Take the time to look back at your question, the research you did, and the conclusions you drew.
   Did you learn what you thought you would?
   What surprising things did you learn?
   What new questions do you now have?
   What new information might you collect?
6. **Discuss**
   How you will share what you learned with the rest of your class?
   What do they need to know to share in your experience?
   How will you present the information? (oral, video, or poster presentation, or a write-up)
   Is there a way that you can get feedback on your process?

Quescussions: A shift from making statements to starting to wonder and ask questions.
This discussion technique was developed by Paul Bidwell of the University of Saskatchewan and is designed to get students thinking of questions as opposed to just answers.

The participants make points as in a normal discussion, but the use of statements is forbidden. Provide a trigger (such as a poem, topic or theme), and then initiate a discussion with the whole class, with the strict rules below. The process will force students to reflect on questions, encouraging deeper involvement and thought than statements provide.

- The discussion can only contain questions.
- The exercise is monitored by the class. (Participants yell "Statement" or make a sound if anyone makes a statement rather than asking a question).
- Do not raise your hand.
- Open-ended questions are preferred to closed questions. "What", "Why", or "How" rather than "Is it true that…"
- Try to ask questions about feeling as well as facts. Try to ask simple knowledge questions as well as sophisticated questions.
- Humor is encouraged, sarcasm is discouraged.
- A question does not have to be directly related to the previous question.

Incorporating Inquiry: Tips for Teachers
Start small! Add inquiry to a lesson that you are already teaching. Inquiry concepts can easily be added to existing lesson plans by starting the lesson activity with an open-ended question rather than definitions and explanations. Another way you might already be incorporating inquiry into your teaching is to model your curiosity or problem-solving thinking out loud: I wonder why the character did that. I wonder why I usually find caterpillars in the same place. I am curious why there are more birds at one feeder and fewer at another.

- **Start with an open-ended question or demonstration**, as opposed to beginning a lesson with definitions and explanations.
- **Gather responses and questions from students** with little comment or direction. Require students to collaborate on designing experiments or methods of inquiry.
- Have student teams **conduct experiments or gather data**.
- **Re-evaluate question** based on new data and re-experiment or collect new data based on revised questions. Have students share what they learn.

- **Pre-planning is important!** Before going to the kids, determine any preliminary factors or characteristics that must be true in order to achieve your larger goals or plans. Consider factors such as scope, the amount of time you'll spend over how many sessions, relationships to other projects, topical focus, age appropriateness, skills you want to use, resources and media, and collaboration techniques. Make any initial decisions that you have to, but let your students decide as much as possible.
- **Identify skills** you want your students to learn. Some basic skills used in inquiry learning include: collaborating, observing, classifying and sequencing, stating problems or questions, problem solving, designing experiments or investigations, data collection, analysis and interpretation of data, defining terms, creating a hypothesis, predicting, inferring, and communicating.
- **Brainstorm:** Assuming the widest range of possibilities, start a discussion in class to find out what the kids are interested in. Ask some broad questions about their interests. Try some simple mapping activities to record the ideas they suggest and to begin winnowing them down to one or a few. Remember, your role is to guide them toward achieving learning objectives and mastery of skills that they need. If they pick the questions that start the inquiry, they'll have no end of such questions, even if you subtly limit the parameters. In most cases, you'll be better off having the whole class work on a single concept or breaking up into teams to work on particular questions, aspects, or executions of that theme or idea. Just make sure that they feel ownership of the topic and truly care about it.
- **Work in teams**. Avoid letting individuals work alone on totally unconnected projects. It's not that there's anything wrong with that, but the kids won't get the advantage of developing collaboration skills and you'll be spread awfully thin trying to help them all on such disjointed topics.
- **Assessment should be focused** on determining the progress of skills development in addition to content understanding. Inquiry learning is concerned with in-school success, but it is equally concerned with preparation for life-long learning.

Sources and Resources:

- Concept to Classroom: Inquiry-Based Learning. http://www.thirteen.org/edonline/concept2class/inquiry/index.html
- The Exploratorium: http://www.exploratorium.org/
- "Field Investigations: Using Outdoor Environments to Foster Student Learning of Scientific Processes." Pacific Education Institute, December 2007. http://www.fishwildlife.org/pdfs/Field%20Investigation%20Guide.pdf
- Inquiry: University of Illinois, Urbana-Champaign. http://inquiry.illinois.edu/inquiry/definition.php
- *Inquiry Based Approaches to Science Education: Theory and Practice*. Wilfred A Franklin. http://www.brynmawr.edu/biology/franklin/InquiryBasedScience.html
- Inquiry by Teachers. http://www.exploratorium.edu/ifi/resources/classroom/connect/greene.html
- NSTA Position Statement: Scientific Inquiry. http://www.nsta.org/about/positions/inquiry.aspx
- "Problem-Based Learning Inquiry Basics." The Center for Teaching Effectiveness, University of Delaware. http://www.udel.edu/pbl/cte/jan95-what.html

- The Process of Scientific Inquiry. http://bumbleboosters.unl.edu/scientific_inquiry.htm
- Scientific Inquiry. http://www.pwcs.edu/curriculum/sol/scientific.htm
- "What is Scientific Inquiry?" David Wetzel. http://ezinearticles.com/?What-is-Scientific-Inquiry?&id=1223526
- What is a good Inquiry question? http://www.mcmaster.ca/cll/inquiry/good.inquiry.question.htm
- YouthLearn Initiative. Education Development Center, Inc. http://www.youthlearn.org/learning/planning/lesson-planning/how-inquiry/how-inquiry

Inquiry Questions

There are numerous categories of questions depending on what the purpose is for the question. Depending on the situation and reason for asking questions, you will ask students different types of questions.

We are focusing on Inquiry questions for this course. Inquiry questions are open ended and researchable. They are questions to which the students do not already know the answer. They should have a clear focus and be reasonable questions to answer, preferably of interest to the students. Frequently, the process of answering one inquiry question will generate another. Inquiry questions encourage students to wonder, think, observe, classify, measure, predict, infer, interpret, analyze, evaluate, and communicate.

Examples of Inquiry Questions

- What did you do next?
- What strategies do you see being used?
- How could you prove that?
- Who would like to share their thinking?
- Does that always work?
- Why did you do that?
- Who used this strategy to solve it?
- Who started the problem the same way?
- How does this relate to _____?
- Have we ever solved a problem like this before?
- What could you do instead?
- What does it look like?
- What does it remind you of?
- What does it feel like?
- What can you do next time?
- What can you tell me about it?
- Which one do you have more of?
- What will you do next after you finish that?
- What are some different things you could try?
- Is there anything else you could do/use?
- How did you figure it out?
- What would happen if _____?
- How did you think about that?
- How could you prove that?
- What do you think would happen if _____?
- What does this make you think of?
- In what ways are these different?
- In what ways are these similar?
- What materials did you use?
- How was that strategy efficient, quick and simple?
- What do you feel, see, hear, taste, smell?
- How did you do that?
- Tell me what it looks like.
- How are you going to do that?
- Is one object longer/shorter than another?
- What do you call the things you are using?
- What you could do with it?
- How do you know?
- What is it made of?
- What can you tell me about the things you have?

Another Way to Look at Questions

Following is a brief explanation of other ways to categorize questions. Inquiry questions can fall into a number of these categories.

Factual Questions are used to gather information. They are questions that you can usually answer by consulting a book, website, or local expert.

- What is the name of this tree or shrub?
- How tall does this tree grow?
- Where does this tree grow?
- What color do the leaves turn in the fall?

Descriptive or Observational Questions are used when you want to focus students on what something looks like or acts like. These questions help to increase student attention to detail as they practice their skills of observation.

- What does it look like? (e.g., size, shape, color)
- What does it feel like? (e.g. texture, temperature)
- What does it smell like?
- What does it sound like?
- When do the leaves turn color in the fall? Do all the leaves turn the same color?
- Is each fall leaf a single color?
- What animals use this tree for their habitat?
- What do twigs look like after the leaves have fallen off?

Comparative Questions compare similar things.

- How do the number of brook trout in the creek from last year compare to the number of brook trout in the creek this year?
- How do our chemical tests and biological samples compare to the state standards?
- Which species of tree grows the fastest?
- Which buds become flowers and which buds become leaves?
- Are deciduous or broadleaf evergreen leaves stronger?

Correlative Questions consider how one thing relates to another.

- How does the number of garlic mustard plants per square foot relate to the amount of sunlight in an area?
- Is fall leaf color dependent on the number of sunny fall days?
- How is hot weather related to disease in pine trees?
- How does water pollution impact the number of frogs in a pond?

Essential Questions are questions that require time to answer them.

- How do trees alter climate?
- What are the physical characteristics of the stream?
- What are the chemical conditions of the stream (dissolved oxygen, pH, etc.)?
- What are the percentages for the different macro invertebrate feeding groups (scrapers, shredders, collectors, predators)?

Resources

- "Field Investigations: Using Outdoor Environments to Foster Student Learning of Scientific Processes." Pacific Education Institute, December 2007. http://www.fishwildlife.org/pdfs/Field%20Investigation%20Guide.pdf
- *Foundations: Inquiry-Thoughts, Views, and Strategies for the K-5 Classroom*. http://www.nsf.gov/pubs/2000/nsf99148/front.htm
- "Inquiry by Teachers."Ash, Greene, & Austin. *Connect* March/April 2000 (vol. 13.4). Synergy Learning. http://www.exploratorium.edu/
- Questions for Science Exploration. http://tlc.ousd.k12.ca.us/~acody/inquiryquery.html
- Science as Inquiry. http://www.worksheetlibrary.com/standards/science/sci1/
- Scientific Inquiry http://www.pwcs.edu/curriculum/sol/scientific.htm
- "What is a good Inquiry question?" Dale Roy, Erika Kustra, and Paola Borin, 2003. http://www.mcmaster.ca/cll/inquiry/good.inquiry.question.htm